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GENETIC PSYCHOLOGY

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To My Parents

PREFACE

The evolutionary point of view has affected the current of scientific thought and research in psychology since the time of William James. This point of view transcends special schools and special psychological doctrines. It is the exclusive property of no one of them. It seems strange, therefore, that, with one possible exception, no text has in recent times specifically reflected the evolutionary or genetic approach to psychology.

This book has been written to meet what the author believes is a real need in modern psychology. The beginning student will find here a frame of reference upon which to arrange the facts of behavior as they are disclosed to him. It may be employed as a textbook where the biological approach is emphasized, and is especially suitable for collateral reading in other general courses. The lay reader, too, may get from it a picture of psychology in its broad biological setting, from which he may safely proceed to an acquaintance with narrower points of view.

Two things have been emphasized, namely, the evolution of structure and the evolution of behavior. Since this is a text in psychology rather than in biology, structure has been emphasized only in so far as it has been necessary for an understanding of the evolution of behavior. The descriptions of structure have been presented in terms as simple and as non-technical as possible. In fact, this has been done to such an extent that the trained biologist might be disturbed at times by the simplicity of statement and the absence of his scientific terminology. However, the essential facts of evolution and inheritance have been presented as adequately as this simplicity of statement permits.

This is a genetic psychology and not another text in child psychology. It stresses both phylogenetic and ontogenetic development. It treats of the whole period of ontogenetic development rather than just one period, in so far as scientific data are available. For instance, the problems of later maturity and senescence, just now beginning to receive the attention they deserve, are considered as an integral part of the life cycle to be embraced in a genetic study.

It is impossible to give credit to all sources from which materials have been collected. When the source is directly apparent, such as in quotations and illustrations, acknowledgments have been made in the text at the places where the materials were used. In addition to this the author is especially indebted to Professor C. L. Turner, Department of Zoölogy, Northwestern University, and Professor W. C. Beaver, Department of Biology, Wittenberg College, for reading parts of the manuscript.

A. R. Gilliland

Evanston, Illinois
April 10, 1933

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GENETIC PSYCHOLOGY

CHAPTER 1

THE PROBLEM

General Statement of the Problem.—The story of the origin of life and its development through countless ages to its highest form in man would be most interesting and instructive. Although, due to a lack of information, many chapters in such an account would be missing, an adequate treatment of the problem on the basis of our present knowledge would fill many volumes. A closely related and equally important problem is that of the growth of man from the time of his conception as a one-celled organism through childhood to his place as a responsible member of society. Here, again, our information is far from complete. Sufficient facts are available in this field, however, to give the student a good understanding of himself and of his fellows. It is the purpose of this text to give a brief survey of the important features in these two developments. Genetic psychology may, therefore, be defined as the study of the evolution of the race and of man. In each case special emphasis is to be placed upon behavior. Structure is to be stressed only as an aid to understanding behavior.

Man has always been interested in his origin as well as in his destiny. Each problem has its biological significance as well as its philosophical and religious aspects. Where, when, and how did life originate? Was it a matter of divine creation in the sense that man was created out of nothing, or did the Creator follow some more natural plan? Is the account in Genesis a full and complete account, or have Darwin and his followers corrected and supplemented this account? These are some of the problems that have concerned the scientist as well as the theologian. In the next chapter we shall consider some of the theories that have been proposed to account for the origin of life.

The Phylogenetic Problem.—We are also interested in the nature of this first life. Was it much like the simpler forms of life that now exist upon the earth? While the answer to this question is only conjectural, there are many facts available which will help us to interpret countless things about these early forms of life. We know, for example, that the atmosphere in which life first existed contained relatively less oxygen and more carbon dioxide than the air we breathe. It is also probable that the temperature was much hotter and the humidity much greater. This leads us to believe that first life was different from most of the simpler forms of life now present in the earth. It was probably much more like certain forms of bacteria than like the amoeba.

In the development from its earliest forms life has undergone many transformations. As has been already suggested, the nature of these changes in many cases can only be conjectured. Some of the facts concerning these changes can be studied from fossil remains. Some others we can trace through forms which now exist upon the earth. In our review of these facts we shall point out the chief steps in the development of both structure and behavior.

The study of prehistoric man can give us some of the differences between man in his earliest known form and the lower animals. This study will also give us an opportunity to investigate the structural and some of the inferred mental differences between earliest man and modern man. However, the actual character of the thinking and the behavior of our earliest ancestors is a subject for much guesswork.

As has already been indicated, our genetic problem is a double one. Not only are we concerned with the phylogenetic development of man from his earliest origin, but we are also interested in the ontogenetic development of the individual.

The Ontogenetic Problem.—Man comes into being as the result of the union of two cells. One of these cells comes from the mother and the other from the father. These cells contain definite factors which determine within certain limits the mental and physical growth of the offspring. These two parent cells unite and form one cell called the zygote. This cell soon divides, subdivides, and resubdivides. The growth of the embryo can be traced in detail from about the fourteenth day. Very early it begins to take on the form and structure of the individual it is destined to be. Yet from its very earliest moment the embryo is subjected to certain forces which modify the course of its development.

Birth is a climactic event. The new-born child suddenly emerges into a world of various stimuli. His hitherto relatively peaceful existence here comes to a sudden close, and he is compelled to cope with a much more complex environment. Instead of getting food through the placenta, the infant must obtain its food by sucking and swallowing, each of which is a relatively complex act. Breathing is another complicated form of behavior that must begin at the moment of birth. Although there are some movements before birth, the active life of the child begins at this time. Indeed, the child is seldom quiet except during sleep. Any one who has attempted to photograph a small child can bear eloquent testimony to this last fact.

In addition to the reflexes of sucking and breathing there are many others that appear, before, during, or soon after birth. We shall leave an enumeration of these till a later chapter.

It is an open question as to how many sensory capacities develop before birth. Vision appears immediately after birth. Other sensory capacities develop rapidly within the first few hours. Although they are relatively obtuse, most if not all, of the senses are present and ready to function by the end of the second week. Their development is very important, for all the higher thought processes depend directly upon sensory experiences.

The fusion and combination of these capacities into perceptions, and the gradual unfolding of definite and skilled acts from the reflex, instinctive, and random movements of infancy will receive special consideration in later chapters. We shall trace the development of intelligence from its earliest origins to adult life. Since language is such an important factor in this development, it will receive separate treatment. Thus we shall lead up to the problems of learning and thinking.

Play, art, and music occupy a large amount of the time of the child and are important influences in his development. The forms of such expression are varied for different ages and racial groups and also differ from one individual to another in similar groups. Much study has been devoted to the play and forms of art of the growing child. A summary of these studies, as well as an analysis of the psychological significance of these modes of behavior, will be presented as a part of the genetic development of the child.

One important phase of life has only recently been recognized in its true significance. Human progress and happiness depend as much upon a healthy, well-developed emotional life as upon physical health or intellectual ability. While there are inherent modes of emotional response, conditioning or learning is just as possible and just as important here as in the fields of skill or thought.

The combined influence of many of the social forces already named and others as well, fashion the social nature or personality of the child. While the basis for this nature is, no doubt, found in fundamental structures and drives, the rôle of learning in the social development of the individual is greater than in many other activities of life. Innate capacity, color, race, and physical appearance are factors; but relations to parents, brothers, sisters, playmates, teachers, neighbors, and others play major rôles in the development of the personality of the child.

It is, in a sense, unfair to select any phase of this personality development for special emphasis. Yet our responses to problems of moral or ethical nature have such a significance in human life that the evolution of morality or character comes in for separate treatment. It will be shown that morality, like other social traits, is chiefly a matter of training. As a rule, our moral leaders come from homes where good social influences have been present, while our criminals are made by poor or evil environments. There may be certain hereditary tendencies toward criminality, but the evidence of a congenital criminality is rapidly disappearing as the problem of delinquency receives more careful scrutiny.

The foregoing account is a brief summary of what the writer considers should be included in a text in genetic psychology. This point of view has the characteristics of a compromise between an extreme biological approach and the more common study of child development. The method used here presents a broad summary of the general field of genetic psychology rather than an intensive study of any single feature of it. Such a summary as is presented in the following pages should give the reader a good orientation to the subject and form a substantial background for further reading. The selected references at the end of each chapter will give a basis for a more detailed study of the various phases of each topic.

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CHAPTER 2

THE NATURE OF LIFE

Statement of the Problem.—What is life? This question has perplexed the profoundest thinkers of the ages. Many descriptions and definitions have been given, but all of them have been found inadequate.

The discussions of this topic may, in general, be divided into two classes. In the one class we may place all those descriptions which consider life as something different *in kind* from non-living material. Such a point of view is known as vitalism. It has been or is held by such men as Koehler, Driesch, and Bergson. Manifestly, such a belief cannot be established by an experiment. Neither is it likely that it can be disproved directly. If life represents something different from the inanimate, it either always existed or was the result of special creation.

Modern adherents to such a view would admit the dependence of life on non-living matter. The plant or animal is dependent upon non-living material for food. Yet the vitalists would claim that life is more than these. It is, they would assert, finally unanalyzable and unknowable.

Science can have no quarrel with such a belief until it is proved false, and this is well-nigh impossible. Yet the attitude of the scientist is always that of seeking for an explanation. He is not content with saying that life is inexplicable until he has exhausted all the possibilities. The vitalists believe that such possibilities have been exhausted or that, when such have been exhausted, life will still contain certain elements which cannot be explained.

The mechanists, on the other hand, believe that they have a purely mechanical explanation for life, or, lacking such an explanation, that such an explanation will eventually be possible. Representatives of this latter point of view include Aristotle, Descartes, Darwin, H. F. Osborn, Jacques Loeb, and John B. Watson.

Characteristics of Life.—Even though the question whether life is different from inanimate matter cannot be answered, there are many things which we know about life. We can describe the physical and chemical composition of living protoplasm, which either is life or is the unvarying accompaniment of life. As each characteristic is considered, we shall raise the question whether this characteristic is unique or whether it is common to both living and non-living material. The characteristics of protoplasm may be listed as follows:

1. Chemical Composition. Man is truly made of clay. He is composed of the common elements that make up the earth: carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, chlorine, sodium, potassium, calcium, magnesium, as well as traces of some other elements. The chemist finds no new elements in protoplasm. He does, however, find them in a baffling combination.

Protoplasm is found in three forms, proteins, carbohydrates, and fats. The chemical formula for a typical protein has been given as $C^{450}H^{720}N^{116}S^{6}O^{140}$. One of the simplest carbohydrates is $C^{6}H^{12}O^{6}$ and one of the fats is $C^{57}H^{110}O^{6}$. There are, of course, many different forms of each of these compounds, and these formulae are to be looked upon as typical rather than as a complete and final chemical description.

There are several interesting facts about the chemistry of life. One characteristic of all protoplasm is the complexity of the chemical constitution. In few of other conditions are the atomic elements bound up in such complex molecules. For example, in the formula for proteins given above there are more than fourteen hundred atoms in the molecule. A further characteristic closely bound up with the one just named is the instability of the compounds. There is a continuous intake of elements and the elimination of others. Furthermore, the balance of these is so delicate that relatively slight changes may seriously disturb or even destroy life. If food elements in the correct proportions are not available, death results. Temperature cannot vary greatly without profound effects. Sunlight is necessary to most forms of life.

This is only another way of saying that living material is susceptible to environmental changes. This feature of living material will be discussed a little later under metabolism and irritability.

2. Physical Properties. Protoplasm has a physical form known as colloidal (glue-like). This means that fine particles of material are suspended in a liquid, chiefly water, in such a way as to make a non-crystalline structure. Neither does the suspended material break up easily into ions. The consistency of this solution may vary from that of the blood to that of the most solid parts of the flesh or skin. In many organisms and in many parts of the human body the consistency of the material is greatly increased by the addition of calcium and other compounds producing shells, bones, or similar structures; yet even here the essential physical structures remain the same.

Some of the further facts about the physical structure is that, as a colloid structure, the cells possess the two characteristics of lack of diffusability and inability to penetrate a membrane. Therefore, the cells of a living organism possess a certain individuality. They are separate and distinct from one another. Most colloids are either transparent or partly so but colored with certain tints. Most plant structures show this characteristic. Even ordinary animal flesh possesses a certain transparency.

Another characteristic is coagulation. Blood, of course, coagulates upon free contact with the air. This is an irreversible process. The blood, once it has coagulated, cannot be changed back again. Other living colloids are coagulated by the action of heat. This is a very important fact. By this process life is destroyed, and by the same process plants and meats are made more digestible as foods for man.

There are both living and non-living colloids. Colloidal structure is not in itself limited to living material and, therefore, is not necessarily a distinguishing feature of it.

3. Metabolism. Protoplasm has the capacity to take in other substances and make them over into parts of itself. Thus,

all living bodies take in other materials, either living or nonliving material, in the form of food and make this food a part of themselves. This is only half the story. The living organism also uses up or consumes part of itself. In so doing, heat and energy are released, along with the production of carbon dioxide, oxygen, and other compounds. Thus protoplasm is able to take material from the environment and change its form into food material or release it in the form of some kind of energy. This is, therefore, a double process. The first of these, the building-up process, is called anabolism; and the second, the tearing-down process, is called katabolism. As a rule both processes go on simultaneously, or at least they must be closely associated as long as life exists. The two processes together are called metabolism.

Whether or not metabolism is characteristic only of living material largely depends upon our definition of this term. A rock takes in heat and gives off heat at times. Moisture is absorbed and in some cases actual chemical changes occur; that is, due to heat, pressure, or other causes, the chemical elements combine into more complex forms. An even better illustration is to be found in crystals immersed in a solution of their own composition. There is an interchange of materials between the crystal and the solution.

It may be claimed that even here the causes of the changes are external to the substance making the changes and that in living matter the forces producing the changes are internal. It is probable, however, that no new forces originate within an organism, that whatever forces seem to originate from within are only conserved energies derived from the exterior. All those who believe that the law of conservation of energy holds in animal and plant behavior must seriously question the creation of any internal forces. If this be true, the difference between the activities in the stone or crystal is one of complexity only from metabolism in living things. While the difference between metabolism in plants and animals and similar activities in nonliving things may be one of degree and not one of kind, yet metabolism and these other activities are generally quite different. They are so greatly different, in most cases at least, that it is not difficult to decide whether a substance is living or dead by the use of this test alone.

4. Growth. Growth is a function of all life at some time in its existence. In most plants and animals it does not continue during the whole life period but occurs only during the early part of the life history of the organism. It occurs when anabolism exceeds katabolism; that is, when the intake of food is greater than the expenditure of energy. When anabolism and katabolism are balanced, growth ceases. As yet there is no generally accepted theory to account for the change in this balance.

Why, for example, does a dog or a man grow to a certain size and then cease growing? Why does the dog grow to one size and the man to another; and, further, why does a rat terrier grow to a certain size and a St. Bernard to another? Of course, we may say that this is the nature of the animal, but this only begs the question. Another, somewhat more sophisticated answer is that there is a limit to the physical-chemical organization of the animal. Growth will continue under favorable conditions until the limit of this organization is reached. When it is reached, the addition of new material would disrupt this internal harmony. Therefore, the plant or animal throws off this surplus. This theory, of course, does not answer the further questions of how or why this balance is derived.

There are some exceptions to this rule of cessation of growth. This is true both in the plant and in the animal world. The Sequoias of California have been adding both diameter and height yearly for many centuries. Some varieties of fish continue to grow for many years at least. It is this fact that so delights the "muskie" fisherman. While there probably is a limit to the size which these fish may attain, under the most favorable conditions some of them grow to be six feet or more in length and to weigh seventy pounds or more.

Is growth a special characteristic of living organisms? A snowball rolling down a hill may increase in size. Is this growth or merely accretion? A supersaturated solution of many chemicals will crystallize. This much more nearly approaches growth, yet the substance of which the crystal is made up is of the same chemical composition as the solution. When food is taken into a plant or animal, the chemical composition of this food is changed. The two processes seem to be different, but this difference may be more superficial than real. No new chemical substance is formed in the assimilation of food. If sulphur or iodine is not taken into the body, none will be found in the body. Therefore, the difference in crystalline growth and the growth of plants and animals may be a difference in degree and not a difference in essential process.

5. Reproduction. All living organisms reproduce. This is necessary for the continuity of life. Plants and animals have various methods of reproducing themselves. Many simple plants and animals reproduce by the dividing of the parent into two or more parts, each of which becomes a new plant or animal. Many plants and some animals reproduce by budding. Sugar cane, for example, is generally propagated by planting small parts of the stalks. These bits of stalks send out shoots, which, in turn, grow into full-sized plants. In higher organisms special cells called germ cells are set apart for the purpose of reproduction. The two types of such reproduction are sexual and asexual. The former is found in the higher plants and animals and the latter in the simpler forms of life.

Is reproduction found in non-living matter? There are at least some very close parallels. A crystal may be broken into two parts and each, when placed in its own solution, will grow into another crystal.

Closely related to reproduction is the process of repair. Most organisms have the capacity of reproducing destroyed parts if the destruction is not too serious. A spider will grow a new leg in a few days; a small area of skin or flesh on man will grow again; a rib or the tibia will soon be repaired. On the other hand, if parts of other bones are destroyed, they will not grow back if the periosteum is destroyed. The parts of the neurone distal to the cell body will ordinarily grow back in place if destroyed. If the cell body is destroyed, repair is impossible. Large areas of body tissue when once destroyed are never restored.

6. Irritability. Irritability is an essential characteristic of protoplasm. When an external force affects an organism, there is an internal adjustment and often also an external adjustment. These adjustments may take the form of gross movements, movement of some part of the organism, internal secretory processes, or growth changes. For example, when a bright light strikes a paramecium it withdraws from the light. Stimulated similarly, a moth proceeds toward the light. Although opposite reactions, they are both due to the irritability of the animal.

In the lower organisms irritability is characteristic of the whole organism; in higher animals, while all parts are susceptible to some types of stimulation, certain parts are especially set apart for this purpose. The sense organs are specialized receptors for various kinds of stimuli. The nervous system is set apart for conducting the nervous impulse, generated at the sense organ, to other parts of the body. This special function we call conductivity. The nervous current is conducted ultimately to a muscle or gland. In the muscle or gland certain changes take place which are called movement in the case of the muscle and secretion in the case of the gland. Thus we have several very closely related functions which are characteristic of all living organisms to a greater or less degree. These are irritability, conductivity, and motility or secretion.

Are these processes limited to living organisms, or are they also functions of non-living matter?

Upon superficial consideration these processes seem to be peculiarly limited to living organisms. A stone or piece of clay does not seem to be irritable or motile; yet there is no known activity in any plant or animal that is self-generated. There is always some external force which is the cause of the activity. Of course, the activity may not be apparent for some time after the external source of the activity has ceased acting. For this reason, we are often misled into thinking that some new principle is involved. The cause and effect relationship so common in the inanimate world is not so apparent, since the plant or animal stores up food or other forms of energy and responds very often not at once but at a later time.

In the plant world we have examples of the transposed and the delayed response. The chemical and physical changes that take place in the leaves and at the end of the roots is incommensurate with the food intake at these points. Other food materials in the case of the leaf, for example, have been transferred here. When the sunlight has produced the changes, food elements are transferred and stored in different parts of the plant. Furthermore, the activity in the flower and seed is specialized.

However, it is in the animal world that we see this principle best illustrated. Stimuli may strike the animal with no apparent effect. Food may be consumed and stored rather than immediately transformed into kinetic energy. At some later time some internal conditions or some slight external stimulus may release a large well of stored energy. Hunger starts the animal on its journey and fight for food. A short word may start individuals or nations into warfare. Likewise, a few kind words or acts may help solve the worst of human conflicts.

It follows, of course, that the strength of the response at any time is not measurable in terms of the present stimulus. The amount of movement in a rock can be estimated accurately by the measure of the force applied to it. On the other hand the behavior of a man is to be explained in terms of his inheritance and past history. It cannot be explained in terms of the present situation alone.

7. Regulation. All living organisms have certain capacities to adapt themselves to varying conditions. A tree may freeze, but it makes many adaptations, such as shedding leaves and growing thicker bark, to adapt to changes in weather. The higher animals have the capacity to maintain an even internal temperature through wide changes in climate. Such internal and external adaptations are so much greater in the animal and vegetable kingdoms than in non-living matter that they become signs by which we can usually distinguish living from non-living matter. It must be remembered, however, that such adaptations are not made by some plants and even some animals. And there is a limitation to the extent of adaptation which any of them can make.

From these discussions it may be seen that there is no single criterion by which living matter can be distinguished from dead matter. Instead we must apply a series of checks, the combination of which usually makes possible a distinction between these two forms of matter. The more difficult problem of what happens when death occurs and what changes take place at this time are too technical to concern us at this time. Suffice it to say that when external conditions become too rigorous or internal disturbances too great death occurs and disintegration begins. The process is irreversible.

The Origin of Life.—We must next concern ourselves with the major problem of the source of life. Whence did life come? How did life originate? Although an absolutely certain solution is perhaps impossible, many theories have been advanced to answer these questions. Some of these are: (1) Spontaneous Generation; (2) Transmigration theory; (3) Cyanogen theory; (4) theory that life evolved from crystals; and (5) Colloid theory. Each of these will be discussed, together with some consideration of its merits and weaknesses.

1. SPONTANEOUS GENERATION. The Greeks believed that life originated by spontaneous generation. They saw life growing out of stagnant pools and decaying matter. What was more natural than to suppose that life was created under these conditions? So simple and easily accepted was this belief, that it held sway for many centuries without any proof against it being offered. Van Helmont, a famous physicist of the sixteenth century, stated that even mice could be spontaneously generated by the simple device of placing some dirty linen in a receptacle together with a few grains of wheat or a piece of cheese. Indeed, it was not until after the work of Pasteur (1822–1895) that the theory of spontaneous generation was generally discredited.

In a sense any of the more concrete forms of the theory of divine creation may be considered a modification of this theory. The one difference is that many who hold the theory of a direct act of divine creation believe that this creation took place once and for all time. Of course, a belief that divine creation is taking place at the present time may be considered a form of spontaneous generation. In this connection it must be stated that unless some other more acceptable theory can be proposed, this theory is just as acceptable as the others or even more so. In fact, probably the majority of scientists believe in some form of creation, but the manner in which it took place or takes place is still a problem.

The theory of the origin of life described by Osborn and Moore as another theory, is really only a modification of this theory. Some of the work of Millikan on cosmic rays leads him to believe much as Moore does that the distinction between matter and non-matter is not so clear as it might seem. It may be true that matter is continually being destroyed and is also being regenerated.

In this much more sophisticated form the doctrine sounds very little like the doctrine expounded by the Greeks. They are alike chiefly in that they both admit that the process of creation is not necessarily ended. They differ largely in the methods of such explanation. The modern view does not necessarily conflict with known laws of reproduction. Instead of supplanting, it supplements them.

2. TRANSMIGRATION THEORY. That life did not originate upon the earth but was transported here from some other planet or passing star is the view held by Helmholtz and Lord Kelvin. The adherents to this theory propose that life was carried to the earth attached probably to some meteorite. This belief does not, of course, answer the question as to the origin of life, it only removes it a step farther. We should still wish to know how life originated upon the planet or star from which it was transported to the earth. There is, however, at least one serious criticism of this theory. The absorption of heat from the sun in interstellar space is almost negligible. In its travels from some other cosmic body the living matter that first arrived on the earth would have been subjected to a temperature of almost absolute zero. An almost complete reversal of these temperature conditions would take place as soon as the atmosphere of the earth was reached, due to the extreme heat produced by friction of any object with the air particles. In fact, most stellar

material is completely oxidized before it reaches the earth. Although, as Woodruff says, certain forms of bacteria have been known to withstand a temperature of −200 C for six months and about −250 C for shorter periods, there is no evidence that life can withstand −275 C. Some spores of other bacteria have been known to withstand temperature as high as 120 C for a short time, but that would not meet the conditions of even the relatively rare carbon dioxide atmosphere of the earlier geological ages of the earth. Therefore, we are comparatively safe in saying that no known form of life can withstand either the extreme cold of interstellar space or the extreme heat of atmospheric friction.

3. CYANOGEN THEORY. E. Pflüger holds that cyanogen is the basis of life. Cyanogen, a compound of carbon and nitrogen, can only be produced under conditions of great heat and with the absorption of large amounts of energy. Pflüger suggested that life originated when the earth was still "an incandescent ball." Then, as decomposition in the cyanogen began, it entered into combination with certain carbon compounds; and, as the cooling of the earth continued, still other compounds were absorbed into the combination. This finally gave rise to the highly labial protein molecules so characteristic of protoplasm. Such a theory cannot be attacked except on the basis of the improbability of such a chemical union as is here indicated under the conditions which are known to have existed when life first evolved.

4. Another theory, proposed by PARMELEE, points out the similarity in structure between living cells and crystals. He suggests that certain crystalline structures developed in the ocean. Under varying conditions structures became more complex and from this beginning life evolved. But this seems to be a rather long step to take without more evidence or proof of the probability for its having taken place. Further evidence against this theory is the fact that life is colloidal rather than crystalline in structure. While the differences and transfers from colloid structure to crystalline are not impossible or even sometimes uncommon they are rather unlikely in this case.

5. THE COLLOID THEORY. Another more generally accredited theory is that life developed from one of the inorganic colloids. A colloid is one chemical substance in suspension in another. It differs from a solution in that the substance in suspension is not easily ionized. Since protoplasm is a colloid, the only problem in this theory is to discover how one of the inorganic colloids became organic. Just how the change in complexity and increased katabolic activity came about is unknown. Whether it came about suddenly or gradually is not clear, but it is likely that it was a gradual process. This theory in some form or another is held by many modern zoölogists. H. F. Osborn in his account of this process lists the following steps in the life process.

(a) The assemblage of the ten elements most essential to life: hydrogen, oxygen, nitrogen, carbon, phosphorus, sulphur, potassium, calcium, mercury, and iron.
(b) These bound together by a new form of mutual attraction forming a new entity.
(c) These elements occurring in a gelatinous state described as "colloidal."
(d) Evolution of the colloid into a more complex state through the activity of catalyzers or enzymes.
(e) Better adaptation as a result of the process of natural selection.

6. Another very interesting theory has been well stated by Benjamin Moore.[1] He says:

> It may be summed up as a general law universal in its application to all matter although varying in intensity in different types of matter, and holding throughout all space as generally as the law of gravitation—a law which might be called the law of complexity—that matter so far as its energy environment will permit tends to assume more and more complex forms in labile equilibrium. Atoms, molecules, colloids, and living organisms arise as the result of operations of this law, and in the higher regions of complexity it induces organic evolution and all the many

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[1] Benjamin Moore, *The Origin and Nature of Life,* Henry Holt & Co., 1913, pp. 189–190.

thousands of living forms. At still higher levels it forms the basis of social evolution and leads to that intellectual development in individual and community which surmounts the whole and is ever building upwards.

In this manner we can conceive that the hiatus between non-living and living things can be bridged over, and there awakens in our minds the conception of a kind of spontaneous generation of a different order from the old. The territory of the spontaneous production of life lies not at the level of bacteria, or animalculae, springing forth into life in dead organic matter, but at a level of life lying deeper than anything the microscope can reveal, and possessing a lower unit than the living cell, as we form our concept of it from the tissues of higher animals and plants.

In the future, the stage at which colloids begin to be able to deal with external energy forms, such as light, and build up in chemical complexity will yield a new unit of life opening a vista of possibilities as magnificent as that which the establishment of the cell as a unit gave, with the development of the microscope, about a century ago.

It was no fortuitous combination of chances and no cosmic dust, which brought life to the womb of our ancient mother earth in the far distant Paleozoic ages, but a well-regulated orderly development, which comes to every mother in the universe in the maturity of her creation when the conditions arrive within the suitable limits.

Given the presence of matter and energy forms under the proper conditions of energy and complexity of matter in the fertilized ovum, one change after another must introduce itself and give place to another and spin along in kaleidoscopic sequence till the mature embryo appears, and this in turn must pass through the phases of growth, maturity, reproduction, decay, and death.

If this view be the true one, there must exist a whole world of living creatures which the microscope has never shown us leading up to bacteria and the protozoa. The birth of life lies not at the production of protozoa and bacteria which are highly developed inhabitants of our world, but away down amongst the colloids, and the beginning of life was not a fortuitous event occurring millions of years ago and never again repeated, but one which in its primordial stages keeps on repeating itself all the time and in our generation. So that if all intelligent creatures were by some holocaust destroyed, up out of the depths in process of millions of years intelligent beings would once more emerge.

If nothing more, this is at least a most ingenious theory. Of course the proof for such a theory is impossible. Furthermore the array of known facts upon which it is based is very technical in character. Only our best scientists are prepared to pass critical judgment upon it. The rest of us must accept or reject it largely on the basis of limited facts and its seeming reasonableness or unreasonableness.

The Early Forms of Life.—Our third important question concerns the *form of the first living organisms.* Was it like anything that now exists on the earth? Was it animal, plant, or something different from either? Before considering this question it will be profitable for us to recount some of the facts about the structure of the earth, its atmosphere, and its climate at the time life first appeared. The most generally accepted theory concerning the origin of the earth holds that before life originated the earth was a molten mass probably considerably smaller than it now is. It was without an atmosphere and continually disturbed by additions from surrounding meteorites and stardust and by internal eruption and disruptions due to rapid cooling and contracting.

As the cooling proceeded a crust formed on the outside, surrounding which was an atmosphere much different from our present atmosphere. It was lacking in free oxygen and highly charged with carbon dioxide. It also contained a large percentage of fine particles of cosmic substance from stars and meteors. In addition to this there was a great deal of water vapor. This blanket tended to screen the bright sunshine from the earth and keep the temperature relatively constant. As cooling proceeded water covered large portions of the earth's surface. This water contained all sorts of chemical elements. It was probably in some sort of world as this that life first evolved.

We cannot be sure of its form. It seems certain that our modern protozoa, such as the amoeba, were not the first forms of life. Probably even the simplest modern plant forms could not live under the conditions described above. It seems more likely that the first life was yet more primitive than either of these forms. It was probably more like some of the bacteria. Some forms of bacteria are able to maintain life for a long time without much intake of food or air. Certain forms are able to utilize almost pure carbon and silicon for food.

Plants contain chlorophyl which has the unique capacity of absorbing sunlight and using it to transform food into starches and sugars. We do not know whether these earliest forms of life contained chlorophyl or not. Probably they did not. When chlorophyl did become a part of the plant a great step forward was made. Thereafter the problem of utilizing different kinds of foods and making them a part of the plant became much simpler. The plant was then able to store foods for growth and other body uses. Plants, however, are relatively immobile.

Some time in the evolutionary process additional nitrogen compounds must have been combined into the plants, the cell wall reduced, and greater motility obtained. This was the beginning of the animal series.

Instead of trying to follow the story historically from this point we shall rather trace in brief detail the evolution of the various structures and behavior series from the simplest to the most complex forms. Our chief interest will be centered in animals rather than in plants. Our treatment will also be limited to present forms and will begin with the amoeba and end with man.

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CHAPTER 3

THE INVERTEBRATE SERIES

General Description.—The invertebrate animals are the simplest forms that have lived and that are now living on the earth. They are, as the name indicates, those animals that do not have vertebrae or a spinal column. This group includes the single-celled animals such as the amoeba and the larger, more specialized animals such as crabs, clams, worms, and insects. In this chapter we shall briefly trace the evolution of the series from its simplest forms up to those that are the direct ancestors of the higher vertebrate series.

Protozoa

The Amoeba.—Protozoa is the name given to the simplest forms of life now existent on the earth. Of this large group of single-celled animals the amoeba is the most typical. There are many species of this animal, but they are all much alike in general structure and behavior. The typical amoeba (amoeba proteus) is about 1/100 of an inch in diameter and consists of two layers of protoplasm, an outer layer called the ectosarc and an inner darker mass called the endosarc. The typical endosarc contains a nucleus, a contractile vacuole, and one or more food vacuoles.

The ectosarc, while not a true membrane, performs the general function of a membrane. It is relatively thick and tough, while the endosarc is thin and mobile. Contractile vacuoles arise as bubbles near the nucleus and move toward the exterior. As they move outward they grow larger. When they arrive at the surface, they burst. The function of the contractile vacuole is not entirely clear, but it seems to perform crudely the function of excretion, releasing from the organism excess water and waste products. Food vacuoles perform the opposite function for the intake of energy.

Behavior of Amoeba.—The amoeba moves about by projecting a part of itself in the direction toward which it is proceeding. This portion of the animal which projects out from the main part of the body is called a pseudopod (false foot). Into this pseudopod the remainder of the body moves. When the pseudopod becomes the main bulk of the animal, a new pseudopod is developed. This is its method of locomotion. A change in direction of movement is produced by a change in the part of the body and in the direction in which the pseudopod develops. A reversal of direction takes place when the new pseudopod develops on the opposite side of the body from that in which the pseudopods have been developing.

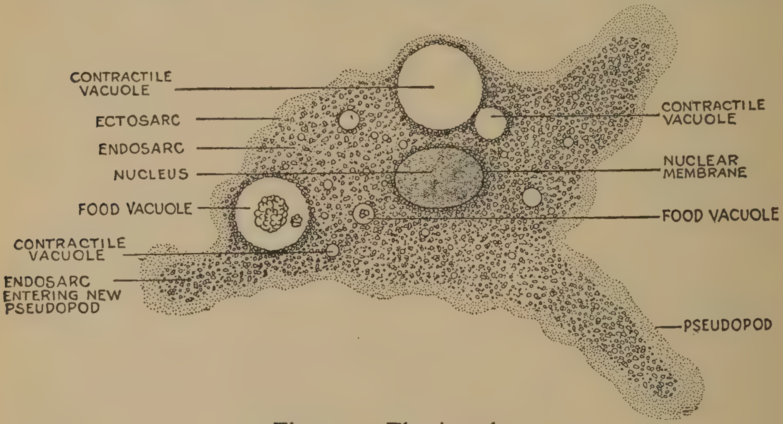

Figure 1. The Amoeba
(Drawing furnished by Professor F. D. Barker, Department of Zoölogy, Northwestern University)

Because of the development of pseudopods the shape of the amoeba is constantly changing. While the typical shape may be considered as globular this is only an average of all the possible different shapes and is not the common shape of the animal body.

The amoeba feeds by wrapping itself around small particles of food. There is no special part of the organism set apart for this function. The food is ingested into and digested by any part of the body with which it comes in contact. The food as it is surrounded by the amoeba forms a food vacuole. Into this food vacuole digestive juices are secreted from the surrounding protoplasm. As digestion takes place particles of the food material are changed and become parts of the animal body.

Reproduction in the amoeba usually takes place by binary fission. This is one of the simplest types of reproduction: the parent amoeba divides into two daughter cells. There is no special process of separation of parts as in the higher forms of reproduction. There is a constriction in the cell wall which divides the ectosarc and endosarc into two parts. This constriction grows until it completely separates the animal into two parts. After separation each cell grows in size and very soon becomes an adult animal.

After several generations of reproduction by fission, the amoeba reproduces by another method called sporulation. In this process the amoeba, after a period of inactivity, divides into many small particles called spores. These spores then develop into full-sized amoebae. While we know that environmental conditions have an effect upon the time and rate of sporulation, there are many conditions and features of the process which are not fully understood.

While the response of an amoeba may be said to be either that of approach, withdrawal, or food getting, such a formula is entirely too simple to tell the whole story of the behavior of this animal. In fact, Jennings, who probably has studied the behavior of the lower organisms more carefully than any other biologist, says that if the amoeba were a large animal so as to come within the everyday experience of human beings, its behavior would at once call forth the attribution to it of states of pleasure and pain, of hunger, desire, and the like, on precisely the same basis as we attribute these things to a dog.

The common behavior of the amoeba, like that of plants and the lower animals, is called tropisms. Such behavior is either positive or negative response to stimulation. It occurs in plants and animals without nervous systems as well as in simpler animals with a nervous system, and hence may be looked upon as more elementary than reflexes. The more common tropistic responses of the amoeba are as follows:

1. Phototropism (response to light)
2. Thermotropism (response to heat)
3. Thigmotropism (response to contact)
4. Chemotropism (response to chemicals)
5. Galvanotropism (response to galvanic current)
6. Geotropism (response to gravity)

Whether the response is positive or negative depends upon the strength of the stimulus and the condition of the organism. If the facts are known the response is relatively easy to predict. The behavior of even the simplest organism, however, is not completely predictable. This raises an important point upon which neither the biologists nor the psychologists are agreed.

Those who hold to the tropistic theory believe that the lack of predictability of behavior is due to the complexity of the organism. If we knew the structure and the stimulus, we could always predict the behavior. Watson and Loeb are exponents of this theory.

Another group, represented by such writers as Jennings and Miss Washburn, holds a quite different view. Jennings declares that by a process of trial and error the innate tendency of the organism is modified. Through trial and error even the protozoa are claimed to have certain controls over their own activities. Hence it is asserted that they are not mere automata but show the beginnings of choice and voluntary control.

A more speculative, and, to the author, a less fruitful discussion arises as to whether these lowly forms of life have consciousness. Miss Washburn gives the following criteria, taken from Yerkes, as a test for consciousness.

I. Structural Criteria
    1. General form of the organism (organization)
    2. Nervous system (neural organization)
    3. Specialization in the nervous system (neural specialization)

II. Functional Criteria
    1. General form of reaction (discrimination)
    2. Modifiability of reaction (docility)
    3. Variability of reaction (initiative)

Miss Washburn[1] continues:

> We know not where consciousness begins in the animal world. We know where it surely resides in ourselves. We know where it resides beyond reasonable doubt in those animals of structure resembling ours which rapidly adapt themselves to the lessons of experience. Beyond this point, for all we know, it may exist in simpler and simpler forms until we reach the very lowest of living beings.

As evidence that she believes that this last is true we need only note that the subject of the chapter which follows immediately after this quotation is entitled "Mind of the Simplest Animals—The Structure and Behavior of the Amoeba."

It is not the purpose of the author to deny the existence of mind in lower organisms. Neither is it denied that they may profit by trial and error. So long, however, as we treat psychology as a science and use the scientific method of study, the view of Loeb appears to be the most hopeful of producing constructive results.

A more important problem concerns the possibility of learning in the amoeba. Our answer to this question may depend partly at least upon our definition of learning. If we make our definition broad enough to include adaptations to certain forms of stimulation, such as the presence of some relatively harmless substance in the water in which it lives, the amoeba learns.

Jennings[2] believes the amoeba learns in a broader sense than this. He tells of a large amoeba which swallowed a small living part of another amoeba which had just been severed. There was a small opening in the large amoeba and, after a short period of dormancy, the small amoeba became active and finally escaped. The large amoeba thereupon pursued its prey and again engulfed it, only to have it escape again. This process was repeated several times. The whole performance lasted about fifteen minutes and finally ended by each amoeba going its own way. Jennings says: "It is difficult to conceive each phase of action of the pursuer to be completely determined by a simple present stimulus." He believes such action is not a reflex but evidence of learning. However this may be, little evidence of any higher forms of learning is to be found in the amoeba.

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[1] M. F. Washburn, *The Animal Mind* (3rd ed.), The Macmillan Co., 1926, p. 33.

[2] H. S. Jennings, *The Behavior of Lower Organisms*, The Macmillan Co., 1906, pp. 17–24.

In summary it may be said of the amoeba that it is one of the simplest of animals: it is single-celled, its life processes are simple, its responses are relatively predictable. Yet in the amoeba we see the beginnings of many of the structural and behavior patterns of the higher animals.

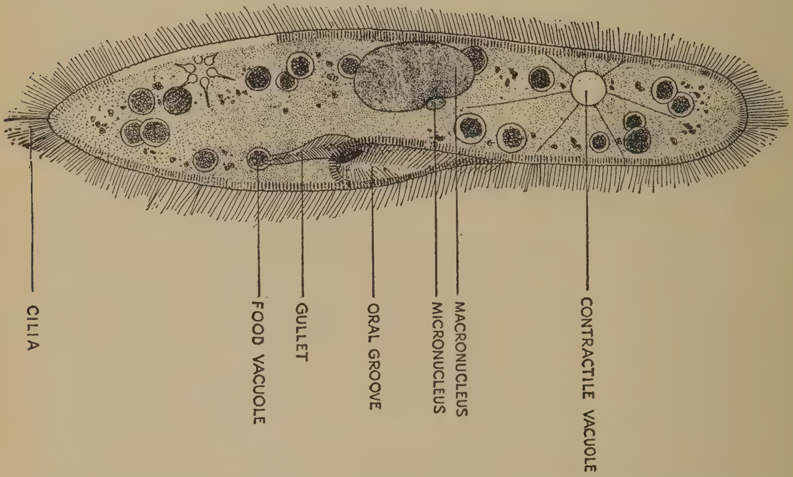

Figure 2. The Paramecium
(Drawing furnished by Professor F. D. Barker, Department of Zoölogy, Northwestern University)

The Paramecium.—Another protozoan which has received almost as much study as the amoeba is the paramecium. Although single-celled the paramecium has differentiated parts for special functions. It is, roughly, cigar shaped with a groove running spirally around its body. It has a relatively thick cuticle, which gives it a definite shape. It is covered with fine hairs called cilia. There is also a clearly defined internal body structure, part of which consists of a roughly defined digestive tract. Food is taken in by action of the cilia along the oral groove which forces food into the mouth. As food particles

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collect, a food vacuole is formed which passes through the food tract where it is digested. The paramecium has two nuclei, one relatively large and one small.

Behavior of the Paramecium.—The paramecium moves by very rapid whiplike movements of the cilia. The direction of movement is spiral, due partly at least to the relatively greater activity of the cilia along the oral groove. Because of the greater definiteness of structure, the paramecium has better means of locomotion than the amoeba. Its movements are specific and direct.

Reproduction in most species of paramecia is sometimes asexual and sometimes sexual. Asexual reproduction is by binary fission but of a more complex form than that of the amoeba. Certain definite structures of the body divide, and each section forms a part of the animal. Something of the nature of this process can be seen from the accompanying diagram. It seems that after a few generations of asexual reproduction, there is a loss of vitality in the organism. Then follows a union of two paramecia in which there is a transference of small nuclei from one individual to the other. This may be considered a sexual act. After separation each paramecium subdivides by binary fission and four individuals are produced. The whole process is rather complex, showing many of the characteristics of sexual reproduction as described in a later chapter of this text. It may be noted here that the transference of nuclei may be likened to fertilization of the egg by the sperm. There are two stages of division which may be compared to the two maturation divisions in sexual reproduction.

The behavior of the paramecium, as contrasted with the amoeba, compares favorably with the greater complexity in structure. It is susceptible to various light, heat, chemicals, pressure, and other stimuli. The response of the organism is not only more complex in form, but more specific in character and less predictable than that of the amoeba. For example, when the animal strikes against some foreign substance, it backs off, turns slightly, and swims forward again. This process is kept up until it escapes or fatigue ensues.

While the paramecium is much better provided for securing food and escaping from danger than the amoeba, it is not able to profit greatly, if at all, from experience. There is a certain adaptiveness and variability of attack that makes it more likely to succeed. Stevenson Smith and Bentley placed a paramecium in a cone of water, the upper diameter of which was considerably smaller than the length of the animal. After many trials the paramecium was able to turn itself over in its small quarters. In later experiments it was able to turn over with fewer and fewer attempts until it did so with very few useless movements. Although there has been an attempt to explain this as due to greater flexibility of the animal because of a loss of "tonus," from the point of view of behavior this looks like the simple beginnings of learning.

It must not be inferred from the two illustrations that have just been used that these are the only kinds of protozoa there are. Each of the two mentioned is only one representative of a large group within the species; furthermore, there are about 8,500 known species of protozoa in all. Allee says, "they live in the ocean, in fresh water, in the soil, and as parasites in both plants and animals. Animals from this phylum cause malaria, sores, dum-dum fever of India, amoebic dysentery, and perhaps small-pox, hydrophobia, and yellow fever." [3]

Metazoa

General Description.—Animals above the protozoa are called the metazoa, that is, animals with more than one cell. Because there are one or two types that have some of the properties of both protozoa and metazoa, the question arises as to whether there is a distinct break between the protozoa and the metazoa. Volvox is a marine animal which may be looked upon either as a community of protozoa living close together or as a loosely assembled metazoön. While this problem has theoretical importance, we are more concerned in the successive steps of evolution than in how animals should be classified.

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[3] H. H. Newman, *et al., The Nature of the World and of Man,* University of Chicago Press, 1927, p. 265.

The Sponge.—The simplest animal of the metazoa is the sponge. There are many varieties of this animal. Some live in fresh water and some in salt water. Some are very small while others are many inches in diameter.

Most sponges are loosely-meshed, stationary animals with a hollow interior. Into this interior food is passed by ciliary action. The sponge is a multicellular animal composed of two layers. The outer layer is composed of flat, denser cells and is called the ectoderm. The inner layer is coarser and is called the endoderm. About the only further specialization in cell structure and function which should be mentioned is that all exposed cells are susceptible to stimulation but certain special muscle cells have the further capacity to contract so as to close the surface pores. There is no nervous system.

Behavior of Sponges.—Sponges reproduce either sexually or asexually. The common form of asexual reproduction is called budding. Small protuberances grow out from the parent and finally break off to form a new sponge. In sexual reproduction both male cells, called sperms, and female cells, called ova, are produced by the same animal. These germ cells unite to form a single cell. The daughter cell generally remains and grows in the parent sponge for a time, and them emerges as a larva. The larva eventually grows into an adult sponge.

Since the sponge is essentially immotile, its behavior is largely limited to food getting. Even in this respect the sponge is dependent upon the presence of food material in the water in which it lives. When food bearing water comes near the sponge, the water is circulated through the sponge and the food products are collected and then digested by cells along the canals and passed on to the other cells of the body. If an obnoxious material comes into contact with the sponge, the external cells are stimulated and the muscle cells close the openings to the internal cavities, thereby protecting the animal from injury.

The Hydra.—Another representative of the simple metazoa is called the hydra, a flower-shaped animal with tentacles at the upper end and a pedal disk with which it attaches itself to other objects. The tentacles are free to move and help to collect food into the mouth which lies between the bases of the tentacles.

The hydra presents two new plans of organization. One type is known as radial symmetry, which means that the principal parts of the organism are arranged like the spokes of a wheel. This type of development will be encountered in our account of higher forms of life such as the starfish. The hydra also presents an axial arrangement, the axis running through the mouth and pedal disk. This axial arrangement forms the basis of bilateral symmetry in higher structures.

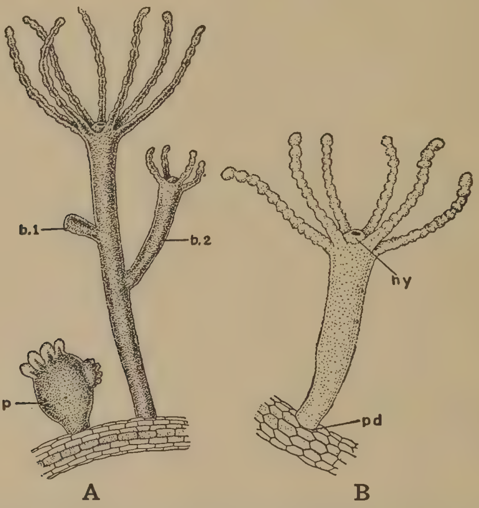

Figure 3. Hydras Attached to Aquatic Vegetation (After Pfurtscheller wall chart)

A. Two specimens of *Hydra viridissima,* the one on the right moderately extended; the one on the left in the fully contracted position (*cp*); *b.1* and *b.2* are, respectively, a young bud and an older bud. B. A specimen of *Hydra oligactis; hy* hypostome; *pd,* pedal disk.

(H. H. Newman, *Outlines of General Zoölogy,* The Macmillan Co., 1925)

The hydra is composed of two layers, an outer called the ectoderm and an inner called the endoderm. The ectoderm acts as a skin and is sensitive to various types of stimulation. There is a special sensitiveness particularly in the tentacles. If a food substance touches a tentacle it moves in an effort to bring the food to the mouth. This special sensitiveness in cells, which are also muscular, forms the basis of what is called a receptor-effector system, that is, the same cell is both sense organ and muscle. There is also some conduction from one cell to another so that adjoining cells contract from stimulation, but this conduction is slow and sluggish.

In addition to the receptor system there is a receptor-adjuster-effector system with sense organs, nerves, and muscles in the hydra. Nerve cells are few in number and are located around the mouth. This nervous tissue consists of a kind of network of cells which facilitates conduction and integrates the action of the organism. There are also some cells that in function are sense organs which receive the stimulation and are connected with the nerve cells. At the other end of the nerve cells there are muscle cells which respond to the nervous stimulation. Therefore, we see in the hydra the special function of the nervous system, that of conduction and integration. Sense organs, nerve cells, and muscle fibers connected into a functional whole form the basis of a reflex arc. We may henceforth speak of the reactions of this type, found in the hydra and all higher forms of animals, as reflex action, rather than as tropisms. In general, stimulation is received by sense organs and conducted by nerve cells to muscles which produce movement. Stimulation is more definite, conduction is more facile, and response is more specific than in tropistic responses.

The hydra possesses a kind of nettle or stinging cells. These are coiled threads which, when touched, dart out and penetrate the obstructing substance. These cells act either as a defensive or an offensive weapon. By means of these stings the hydra is able to protect itself or to kill prey.

Behavior of the Hydra.—Reproduction in the hydra is of two kinds, budding and sexual. Budding is a process by which a small portion of the protoplasm exudes from one side of the parent and begins to grow. This new part gradually assumes the form and shape of the parent, grows larger, finally breaks off from the parent, and develops into a new animal.

The type of sexual reproduction in the hydra is similar to that in the sponge and is known as hermaphroditic, that is, the parent produces both male and female germ cells. These two kinds of cells unite and a new hydra is developed from this union.

The behavior of the hydra is more complex than any of the protozoa or the sponge. It is susceptible to more kinds of stimuli and the type of response is more varied. In food reactions, for example, internal conditions set up activity. This consists of backward and forward movements of the body and gradual movement of its basal disk. If its first responses are unsuccessful it may loop itself over much like a measuring worm. If these movements do not bring it in contact with food, the hydra lets loose and by another series of contractions moves to a new environment.

When some noxious substance is brought into the vicinity of the hydra a somewhat similar series of movements are set up, but in this case they are withdrawal movements. The tentacles are contracted, the mouth cavity is closed, and the body is moved from side to side in an attempt to avoid the substance. If this does not succeed, the hydra releases its hold and moves to another position. The hydra also reacts to physical contacts of light and heat. These types of behavior may be spoken of as a form of heliotropism and thermotropism. In this connection it must be remembered that while reflex behavior is possible tropisms are also to be found even in the highest forms of animal life.

The Planaria.—The next step in the animal series is represented by the planaria or flat worm. These worms have three layers, ectoderm, endoderm, and mesoderm or middle layer. The addition of this middle layer forms the final stage in embryonic development and is found in all the higher animals. The body of the planaria is bilaterally symmetrical, that is the two sides of the organism are similar. Organs which lie on the median plane are single and those on either side are double and one is to be found on either side. Although a few of the higher forms of life are not bilaterally symmetrical, this is a general mark of advancement and is to be found among all the highest invertebrates as well as all the vertebrates.

The planaria has an alimentary tract which has only one contact with the exterior. Food is taken in and exuded through

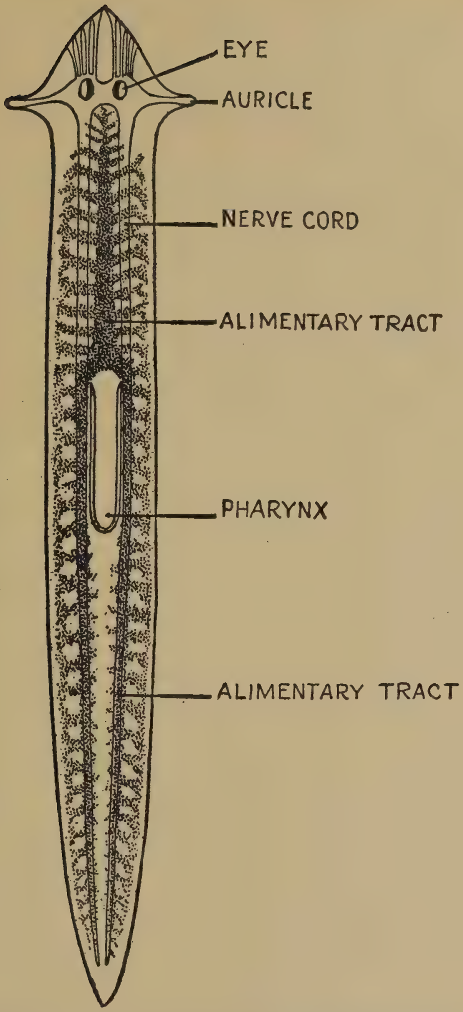

Figure 4. Planaria, One of the Free-Living Flatworms of the Phylum Platyhelminthes. (From Newman, after Child)

the mouth. Two tubes run lengthwise through the body with many fine branches extending to the surface in various parts of the body. This forms the first rudimentary signs in the evolution of an excretory system. In this connection it is interesting to compare the form of the tube with the tubular structure of the kidneys in the higher vertebrates.

Behavior of Planaria.—Reproduction is mostly hermaphroditic but occasionally by fission. The nervous system is larger than that in the other animals we have studied, with a cephalic ganglion, the beginnings of a brain, and two ventral nerve cords that run the length of the body. Branches extend outward at different points from these cords.

As has just been said, planaria are generally hermaphroditic. Each animal supplies both male and female germ cells. Specialized parts of the body produce these cells. However, certain planaria reproduce by transverse fission. Child[4] has made some very interesting studies in regeneration in planaria. By transverse dissection of the animal under favorable conditions each part will regenerate into a normal animal: that is, the part containing a head will grow a tail, and the part without a head will generate a head. Child found that, if the sectioning is done near the head of the animal, there is much more likelihood of each part developing into a normal animal. If the sectioning is farther back, there is still likelihood of the posterior part growing a new head; but the head may be subnormal. If the sectioning is well back, there is much likelihood that the posterior segment will develop a subnormal head or no head at all.

If a small segment is removed from near the head region and metabolism artificially accelerated in the posterior end of the segment, new heads may develop at each end of the segment.

These studies together with others of a somewhat similar nature have led Child to construct his theory of *physiological gradients*. Briefly stated, this theory maintains that the growth of an animal depends upon the rate of metabolism in its different parts. Normally the rate of metabolism is greater in the cerebral region. The gradients become lower toward the aboral pole of the animal.

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[4] C. M. Child, *Individuality in Organisms*, University of Chicago Press, 1915.

This theory emphasizes the environmental factor in reproduction and growth. It may be that the nature and rate of growth of the embryo is controlled by its environment. While genes play their part, the environment, Child claims, has a large part in controlling the rate of metabolism and hence the form and nature of growth in animals.

Segmented Worms.—True worms, best represented by the earthworm, present several new structures. These consist of:

1. Segmentation or metamerism.[5] The body of the earthworm is made up of divisions or parts, each much like the others. The numbers of metameres vary and may be many more than one hundred. Such segmentation, while much elided, is to be found in all higher animals. The bones of the skull and jaws and the vertebrae of man are segmentations.

2. The coelom or body cavity. The body consists of a hollow tube, the alimentary tract constituting the internal opening of the tube. Within the walls of this hollow tube is a cavity not in contact with the outside. This is the coelom. The coelom may be looked upon as the body cavity within which many of the internal organs of the body are suspended. The inside of the chest and abdominal walls and the outside of the alimentary tract form the limits of the coelom.

3. Circulatory system. The earthworm has a series of blood vessels running the length of the body. Five pairs of hearts help to force the blood through these tubes but much of the movement is due to pressure on the sides of the blood vessels from the muscles in body movements.

4. Respiratory system. Respiration takes place all along the body surface, but there is a series of tubes which admit air to the interior of the body and allow the exhalation of carbon dioxide. There are pairs of excretory tubes in each metamere.

5. Nervous system. The nervous system shows many elaborations. There is a well-defined brain. Two neural cords lying ventral to the digestive tract extend the length of the body. Within each metamere there is a local nervous network. The

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[5] Although segmentation is not present in the planaria, it is to be found in tape worms, which belong to the same phylum. However, since segmentation is not a common characteristic of this phylum, we are listing it as a new structure typical of the true worms.

neural connection between metameres takes place through the neural cord. Such an arrangement of the nervous system provides greater integration and organization together with greater specificity of response. This is shown in its behavior.

Behavior of the Earthworm.—Reproduction in the earthworm is truly sexual. There is cross-fertilization, but each animal possesses both male and female reproductive organs. There is a mutual exchange of germ cells in conjugation.

The earthworm moves about by crawling. Crawling consists in a series of contractions which begin in the metameres in one end of the body. The new position is held by means of seta or bristles on the under side of the body. The movement of one metamere is followed by a similar movement in the next until each metamere of the body has contracted. As a metamere contracts it is pulled forward and in turn pulls or stretches the metamere just back of it. After the contraction has passed the length of the body, another set of contractions begins. The contraction in each metamere is controlled by its local nervous tissue. Conduction from one segment to another is carried through the neural cord.

The earthworm gets most of its food directly from the soil. The soil particles are taken into the alimentary canal and, as they pass through, elements are extracted by simple processes of digestion.

The earthworm reacts negatively to light. At night it comes to the surface and, with part of the body remaining in its burrow, it searches for leaves and other types of food. Particles of leaves may be carried into the burrow for feeding during the day. The response to light is more specific than in lower animals. Although all parts of the body are sensitive, parts of the head are especially sensitive to light and may be considered as rudimentary eyes.

Graber[6] found evidence that earthworms not only congregate in dark places in preference to places lighted with white light, but seemed to prefer red light to blue and green light, even when the former was much darker than the latter. Whatever this means, it must not be taken to indicate that they discriminate hues. They are, however, sensitive to brightness changes.

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[6] V. Graber. See Washburn, *op. cit.*, p. 140.

There seems to be no evidence that earthworms are sensitive to sound except when the vibrations are intense enough to produce mechanical stimulation.

Jennings[7] found that the earthworm's behavior was modified by previous stimulation. When in a state of rest a stronger stimulus was necessary to arouse a response than stimulation following excitement. Yerkes[8] found that by giving earthworms an electric shock when they took the darker of two pathways in a maze he could train them to respond to the lighter pathway. This is true learning.

The Starfish.—Structurally, in many respects, the starfish appears to be a regression to an earlier type of animal than the ones we have just been considering. The starfish is radially symmetrical. Furthermore, it has no brain and its nervous system is not much more than a nervous net. Because of these facts the question might be raised as to whether the starfish should not be classified farther down in the animal series. In fact, it is so classified by some authors. However, it has a digestive tract which is more elaborate than that of the lower animals, and it presents one distinctly new structure, a skeleton. This is a further example of an animal that extracts calcium and stores it up within, or rather around, its body structure. This calcium is stored in the form of bony plates in the skin of the animal. These plates are held together by muscle tissue. This platework forms a good protective covering for the animal at the expense of rapidity of locomotion. The feet or rays are covered with pedicellaria, which are small pincher-like processes. These pinchers are set in action by various kinds of stimuli. For example, if a small animal begins to crawl over the starfish, the pinchers seize it. Large numbers of these pinchers cooperate in overcoming the prey. When the prey has been overcome, it is passed toward the mouth by means of a series of tube feet or suckers, which extend in rows along the rays.

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[7] Jennings, *op. cit.*

[8] R. N. Yerkes, "The Intelligence of Earthworms," *Journal of Animal Behavior*, Vol. 2, p. 208.

Behavior of Starfish.—The starfish is expert at feeding on such animals as mussels, clams, and oysters. By arching the body and surrounding the shell of such animals with its rays, the starfish is able, because of its great strength and tenacity, to force open the shell of its prey. It then proceeds to partake of a choice and hearty meal.

Preyer[9] found that starfish when hungry reacted not only to food in contact with its body but at some distance. This response no doubt may be attributed to a chemical sense. How nearly it approaches the sense of smell remains in doubt. Hess[10] found that starfish are sensitive to light and seem to make differential responses to various hues. It responds to objects at a very short distance, such as walls, in a way that indicates an ability to see. Whatever "seeing" it does is accomplished by means of small especially sensitive areas, one of which is located near the end of each ray.

Ven[11] found that starfish could learn to respond with one ray rather than by others as a result of certain rewards and punishments. Jennings determined the ray preferentially used by a starfish in righting itself after being turned on its back. Then by fastening down the preferential ray he taught the animal to use another in righting itself. After several practices these modifications were retained for a day or more. This seems to be a bit of evidence of simple learning, although some writers have questioned whether this learning consisted in some modification in the nervous system or only in muscular facilitation due to practice.

The Molluscs.—This phylum is probably best typified by the snails but also includes oysters, clams, mussels, the octopus, and some other less well-known animals. There are many differences between the various members of this phylum but they present, as a group, certain advances over their forerunners.

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[9] See Washburn, *op. cit.*, pp. 73–74.

[10] *Ibid.*, p. 138.

[11] C. D. Ven, "Sur la Formation d'habitudes chez les Asterier," *Archives Neer Physiol.*, t. 6, p. 163.

The bodies of the molluscs are divided into four main parts: (1) the head, (2) the foot, (3) the cloak or covering for the main part of the body as the organ for secretion of shell materials, and (4) the visceral mass. The molluscs also present refinements in digestive apparatus, circulatory system, and reproductive organs. The nervous system of the snail is much like that of the earthworm except that the cerebral ganglion is more developed and exerts greater control over the rest of the nervous system.

Behavior of the Mollusc.—The snail possesses the senses found in more primitive animals such as mechanical contact, simple vision, and the chemical sense, with very definite evidence of a sense of smell. There is also some evidence of the rudiments of a kinesthetic sense. At least, Newman[12] says, we must assume some method to account for their ability to wander at some distance from their home and return. He quotes Furtado as follows:

> He noticed the Helix Adspera lodged between a column on a veranda and a flower pot containing a growing banana plant, and threw it away into a little court below and six or seven yards distant. Next morning the snail was in precisely the same place on the flower pot. Again he threw it away to the same distance and determined to notice what happened. Next morning at nine o'clock the snail was resting on the rail of the staircase leading to the veranda from the court, in the evening it started again, quickening its pace as it advanced eventually attacking the banana in precisely the same place where it had gnawed before.

A snail which had been kept in a cylindrical glass jar partly filled with water was accustomed to crawl to the surface for air. The level of the water was raised and the snail continued to crawl to the accustomed place and extend its siphons for air as before.

It has been found that snails at first withdraw their tentacles from shadows. After successive trials the snails make fewer and fewer withdrawals until they become habituated to the shadows and do not withdraw their tentacles. This seems to be an example of the elimination of the response through negative adaptation. If this be true it can be considered a clear case of a somewhat higher form of learning than that found in any of the animals we have yet studied.

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[12] H. H. Newman, *Outlines of General Zoölogy,* The Macmillan Co., 1929, p. 216.

The Arthropods.—This group of animals is very numerous. It includes the insects, as well as lobsters and crayfish. It contains many of man's enemies and some benefactors like the bee. This phylum presents more specialization in the digestive and circulatory system than any we have yet studied. The nervous system has a relatively larger and more elaborate cerebral ganglion. The sense organs such as the eyes are well developed. Most of the classes in this group have legs for effective locomotion; in fact arthropod means hinged leg.

The trilobites, which have long since become extinct, are found in the Cambrian deposits; and they probably reached their greatest development in the Ordovician period. They were a snail-like, shell-covered animal with a simple body form.

The class Crustacea includes crayfish, lobsters, and crabs. They are mostly marine but some live in fresh water. This class is characterized by two pairs of well-developed antennae. Most of them breathe by means of gills. This is a distinct advance, which better prepares the animal in its struggle with nature.

The class called insects also comes within this phylum. It includes many different kinds of flies, moths, ants, bees, and wasps. These animals have air tubes for breathing, three pairs of legs, and most of them are provided with wings. There are 450,000 or more species of insects known to man.[13]

The insects provide many new types of behavior and have received much study. Many anecdotes have been told about them. Much careful work has also been done with members of this phylum.

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[13] There are four stages in the life history of the typical insect. The first is the egg. The second is the larval stage. The larva is a wormlike animal, generally with a vicious appetite. It is the larvae of certain moths that eat holes in woolen cloth. The leaves of trees are sometimes eaten by other larvae until the trees are made bare. The third stage is the chrysalis. Often in this form the animal wraps itself in a cocoon. The silkworm is a notable example. In the chrysalis stage the animal is inactive. The fourth and last stage is the adult animal. The form of the animal is seldom similar to any of the other stages. For example, the larvae of mosquitos live in stagnant pools, while the adult mosquito does not frequent the water. The common "woolly worm" bears little resemblance to the butterfly into which it later develops. The adult animal is more active, often does not eat, breeds, and lays the eggs for a new generation.

This fourfold existence is rather unique. It is not to be found in the lower phyla; and, although present in some of the higher animals, such as the frog, it is absent in the mammals. There are both advantages and disadvantages in such a manifold existence. It provides a separate form of life for changing climatic conditions and food supplies. However, such variations have their disadvantages in that each condition of the animal must have its appropriate environment, or the life cycle is broken.

The sensory equipment of the insects is rather elaborate and in some cases is very keen. Not only are they able to taste and smell, but these senses are separated and differentiated. Ants fed on honey soaked in strychnine would taste the honey and then leave it. The taste organs seem to be located in the mouth while smell is probably located in the antennae. There are some striking examples which indicate how keen the sense of smell must be.

Riley[14] placed a female silkworm in a wicker cage and liberated a marked male a mile and a half away. Within a few hours the two were together. He explained this on the basis of the odor of the female. Fabre[15] found sixty males around a female *Bombyx du chene* in a short time although he had not seen a specimen in this neighborhood for twenty years. When the female was placed in an airtight box the males were not attracted to her. Other odors placed in the vicinity did not have any effect. Bees trained to come to a certain odor were able to discriminate clearly between as many as forty-four different odors. The only ones that they confused were those that smelled much alike to man. Orange peel, for instance, they confused with bergamot and cedar.

Ants and bees seem to locate food by the sense of smell. Results are conflicting as to whether sight plays any important part in the process with bees. It appears that ants find their trails by the sense of smell. Any change, as the removing of a part of the pathway, breaks up their return journey until they hit upon some other part of the pathway. Bees, of course, cannot use the sense of smell for following their track on the way back. It still remains a mystery how they get back from journeys of three or four miles from the hive. Ants and bees recognize members of their own hive or colony by smell. A bee in a foreign hive is killed unless a hive has lost its queen and has been adopted by another hive. Most insects have compound eyes and many of them possess rather keen sight for short distances at least. Just how much use bees, ants, and flies make of sight still remains in doubt.

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[14] C. V. Riley, "The Sense of Insects," *Nature*, Vol. 52, p. 209.
[15] J. H. Fabre, *Souvenirs Entomologiques* (9 vols.).

The question as to whether insects hear is another problem that has not been settled. Some investigators find evidence that they hear and others find there is no such evidence. The argument that those insects like locusts and crickets which make sounds must also hear is interesting even though not necessarily convincing. It is certain at least that most insects respond to mechanical contacts produced by vibrating media. When, therefore, the tone is low enough and loud enough, such animals will respond to such stimuli. Further than this, as intimated above, we are not certain about the sense of hearing.

Behavior of Anthropods.—Spiders have a capacity for learning commensurate with their place in the animal series. It has been found that a spider will learn to remain at its place in the web when a sounding tuning fork is brought near it although at first it is frightened away. We have already mentioned the association formed by bees for different odors. Even as a boy, the writer was rather strongly impressed at times by the ability of hornets and bumblebees to locate their disturbers at some distance.

The most important part of the behavior of insects is the swarm or colony organization of many species. Some insects like the common house fly or solitary wasps are non-gregarious; but bees, many wasps, and ants are especially gregarious.

The organization of society in a beehive is most elaborate. There is the queen whose duty it is to lay eggs, the drones who are consorts for the female, and the workers, who have various but well-organized duties. Among these latter it is the duty of some to care for the queen, of others to gather honey, of others to carry water; while still others seem to act as police.

Ants sometimes have an even more elaborate organization than bees. In addition to the organization already described, they construct underground tunnels and chambers for homes. They care for and protect aphids. In turn these aphids exude a sweet fluid which ants eagerly eat. These aphids have much the same relation to ants as domesticated animals do to man.

We are told that certain ants carry away the pupae of other ants and rear the young as slaves. Equally interesting and marvelous is the story of the egg-laying activities and storage of live food carefully paralyzed by stings for the yet to be hatched larvae of certain wasps.

Many fantastic anecdotal stories are told of the life of insects, some of which may be true, but others of which are certainly false. The question with which we should be most concerned is how we may explain the facts which we know to be true. Are ants, bees, and other insects possessed with a mind and have they deliberately worked out these elaborate systems of social organization to meet a recognized need? If any one holds such a view it would be hard to convince him otherwise. To those who hold that such behavior can be explained on simpler grounds, the more anthropomorphic view is equally untenable. Suffice it to say that in the interest of parsimony—which of course may be easily overworked—and in line with the views held by most careful students of animal behavior, the writer is prejudiced toward the latter view. How then may we account for such complex behavior of insects? A careful study of the structure and behavior leads us to believe that they react on the basis of reflexes and instincts or whatever term the reader wishes to use for innate, predetermined predispositions to respond in certain ways without the necessity of previous experiences. How such complex behavior became a part of the native equipment of these animals presents another interesting but difficult problem.

Was it a matter of natural selection in the life history of the individuals? Did those insects that cooperated live to reproduce their kind and did succeeding generations find more effective ways to cooperate? If so, how were these more effective methods passed on to later generations? Did the modifications come as a result of chance or was there some direction to such modification from the environment? Even an attempt to answer these questions would consume the remainder of the space of this text, and at the conclusion we probably would be little nearer an answer than we now are; at least most students who have given thought to the problem would not change their opinions on these matters as the result of such discussions.

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CHAPTER 4

THE VERTEBRATE SERIES

General Description.—Although in point of time required for development and in the number of species the invertebrates may appear important, they are as a rule not nearly of so much interest to man as the vertebrates. Of the nearly 650,000 known species of animals only about 56,000 belong to the vertebrate group. Despite their relative infrequency in numbers, there are at least three reasons why we are more interested in them than in the invertebrates: first, because they show greater and better adaptation to living conditions; second, they are larger and hence more easily seen and studied; and third, because man himself belongs to this group.

Let us consider some of the structures which are peculiar to the vertebrates.

1. They have a skeleton within the body instead of on the outside. This change makes for greater flexibility of movement both in defense and offense. Bony structures on the outside, such as we find in crayfish and insects, are a good defensive weapon; but such structures cannot be other than a hindrance when speed of escape or attack is essential rather than protection.

Besides the advantage of relative efficiency through a reduction in weight and increase in flexibility, the internal skeleton with a skull and vertebral column as a central feature provides specific protection for the nervous system. The brain and spinal cord of the vertebrates are encased in this bony framework. This is another advantage to the vertebrates in their adaptation to the environment.

2. The vertebrates are covered with scales, feathers, or hair. Scales for animals that live in the water, hair for animals that live on the land, and feathers for animals that live in the air provide protection not afforded by the invertebrates. Although

certain fishes have lost most of their scales, other animals like the frog have only a slight covering of hair, and man has substituted clothing for the most part for hair, yet in general the life of the vertebrates has been protected and prolonged as a result of these various structures.

3. Another step in the evolution of the vertebrates is hinged jaws. The typical jaws of the higher invertebrates are the pincher-like mandibles. The vertical arrangement of vertebrates generally with one jaw movable and the other stationary is an adaptation which materially aids in the process of food getting. This is true whether the food getting is of the kind used by fishes, eagles, lions, sheep, or man.

Two important questions arise in this connection. First, did these new adaptations which have been mentioned arise simultaneously? Second, did the vertebrates develop from some of the more lowly forms? The latter question will be considered first.

Although authorities are not all agreed, the simple fish-like invertebrate chordate known as amphioxus has been given credit as the progenitor of the vertebrate series. By gradual steps the various structures present in vertebrates have evolved. There is no hard and fast line of demarcation between the invertebrates and the vertebrates. Many of the characteristics of the vertebrates are to be found in the higher invertebrates, and the lower forms of the vertebrates, such as the limbless and jawless lampreys and hag fishes, lack many of the distinguishing characteristics of the vertebrates. The evolution was certainly a slow, gradual process.

Other additional characteristics of the vertebrates are the highly-developed circulatory, respiratory, and digestive systems. The sensory equipment is also much more complete with visual, olfactory, and auditory organs better adapted to meet life problems.

The first true vertebrates with all the characteristics of their group are the fish. Next in order come the amphibia, such as the frogs, followed by reptiles, birds, and lastly mammals. We shall take up each of these classes in order. Our greatest interest will center about the development of sensory capacities, the central nervous system, and characteristic behavior. Only incidental attention will be paid to other changes in structure. Instead of taking up each subclass and order under each subphylum, one or at least only a few typical examples will be selected under each class. Even this program will not be adhered to strictly since the first class, cyclostomata, which presents few characteristic differences from the invertebrates, will not be included in our discussion further than to point out some of their chief characteristics.

The Cyclostomata.—The lampreys and other cyclostomata are a primitive form of fish. Many of them have sword-like tongues which they use in catching their prey. They have cartilage rather than true bone. The fins are not paired as in true fish. They present an outward appearance resembling a cross between the reptiles and a fish. In reality they represent the nearest link between the invertebrates and the vertebrates.

The lampreys, like some of the higher invertebrates, belong to the phylum known as chordates. In fact, all the vertebrates belong to a subphylum of this larger group. The distinguishing characteristic of the chordates is a hollow nervous system. In this phylum the nervous system is developed as an infolding of the ectodermal layer of the embryo. In this infolding the inner core of the fold is preserved as a hollow tube extending through the spinal cord and into the brain. Especially in the brains of the higher chordates this cavity is enlarged in places which are called ventricles. These ventricles as well as the opening in the cord, are filled with a liquid called the cerebrospinal fluid.

Two other characteristics distinguish the chordates from the lower animals. They have a notochord which ordinarily develops into a spinal column. The presence of this spinal column is the distinguishing feature of the vertebrates. In embryonic development the nervous system develops dorsal to (back of) the notochord. This is a further feature of all the higher animals which separate them from the lower invertebrates, since the latter generally have their neural tubes ventrally located in their bodies.

The last feature of the chordates is the presence of gill slits at some time in their existence. In fish these gill slits are present in the adult animal. In frogs they are present in the tadpole stage. In the higher mammals, including man, they are found only in the embryo.

The True Fish.—Fish present several new structures. Fish have true bone. The skeleton is composed of a skull, a very flexible vertebra and long slender ribs. Fins are bone-like structures which are used to shove the fish rapidly through the water. Most fish have a scaley covering, although some varieties such as the trout have very few scales. Fish are provided with a large air sac which reduces the specific gravity of the body and makes swimming easier.

Most fish reproduce by the female laying the eggs in some convenient place where they are fertilized by the male. In some species the female and in others the male cares for the young. However, mortality is very high. Thousands of eggs are laid for the few fish that ever live to be large enough to reproduce their kind.

While the true fish are adapted only to life in water, they present certain advances over the lampreys and dog fish. These advances are evident in sense organ, neural, and general bodily structure. Both the cerebrum and cerebellum are more highly developed. The olfactory lobe and pallium are more closely associated with the optic lobe. The fins are paired and the lower jaw is hinged.

These facts, together with several others, make it seem probable that fishes are not a direct descendant of the lampreys but rather that they both developed somewhat parallel. For some reason the higher type of fishes developed farther than the lampreys. This phenomenon appears in the relation not only of lampreys and fishes but of many species and classes of animals. The reptiles and birds, which we shall study later, are not direct descendants from modern amphibians, but each was evolved from some early common parent. The earliest reptiles in turn developed in several directions. Modern birds represent one development and mammals another. Apes, monkeys, whales, elephants, and man represent further more or less parallel mammalian developments.

Experiments have been performed in an attempt to discover to what extent, if any, fish are able to discriminate colors. Bentley and Washburn trained a creek chub so that it bit at a forcep to which red sticks were attached. The chub did not bite at green sticks. The brightness of the green was varied above and below that of the red and still the fish was able to discriminate. Von Frisch dissected the eyes of some fish immediately after they had been looking at colored objects. He claimed that the cones of the eyes were pulled back in line with the field of vision, while the rods were stretched out and partly buried. He found the reverse in dark adapted eyes. The evidence does not appear conclusive. After reviewing the literature, Watson believes fish are colorblind while Washburn[1] thinks they can discriminate color. Meanwhile the fish-bait makers will go on making their lures in bright colors, not knowing whether black, white, and gray would not be equally effective.

The question of the hearing of fish also remains unsolved. As a youngster the author remembers being cautioned by his elders that he must not talk or make any noise while fishing. Yet the experiments on the topic lead to no unequivocal answer. It is probable that at least some kinds of fish do hear. The structure of the ear leaves the question open as to whether hearing is performed by the ears. If fish do hear, it may be through the lateral line canals rather than through the ears.

There is no question but that fish have rather keen senses of taste and smell. Like so many other animals they use these senses in choosing food. It is only the different varieties of game fish that will take an artificial bait. Other varieties of fish examine their food and sample it before swallowing it. Mention has just been made of the possible use of the lateral line canals located along the sides of the snout. We know that they are connected with the seventh pair of cranial nerves. These nerves possibly perform a function intermediary between touch and hearing. They may be used by fish in orienting themselves in the water. A fish normally heads upsteam. The current of water stimulates the sense organs which in a reflex manner causes this orientation.

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[1] M. F. Washburn, *The Animal Mind* (3rd ed.), The Macmillan Co., 1926, p. 145.

The Learning Capacity of Fish.—Of course every fisherman knows from practical experience that fish learn. The resorts that have been frequented by fishermen are not the place to catch fish, not only because there are fewer fish, but also because the fish that are there are more wary. Some kinds of fish are much harder to catch than others. Almost any one may catch sunfish, but only the skilled fisherman can catch trout. Furthermore, the older fish are harder than the young ones to entice to take the hook. It is only the skilled fisherman who is likely to simulate natural feeding conditions successfully enough to catch the big ones.

Several studies have been made of the learning of fish. We have already mentioned the experiment in which fish learned to discriminate between red and green. A carp was offered a bit of worm on a barbless hook. When it bit it was pulled out of the water, taken off the hook, and returned to the water. For a while thereafter the carp avoided all food. Later it learned to discriminate between worms with hooks and worms without hooks by ejecting water toward the worm to see if it were free moving or attached.

Mobius[2] placed a pike in the aquarium separated from some minnows by a glass partition. At first the pike darted at the minnows but received a bump from the glass partition. Finally, after about three months, it learned to leave the fish alone. The partition was removed later and the minnows swam around the pike without molestation. Triplett[3] performed a similar experiment with a perch separated from minnows by a glass partition. The perch not only learned to refrain from attacking the minnows, but after the partition was removed it would stop at the point where the partition had been as though expecting to bump against it. Pieron[4] placed live worms in a glass tube and suspended the tube in an aquarium with a cyprinoid fish (carassius antatus) for twenty-seven minutes a day. The first day the fish made 117 attacks and on the next three days, 58, 38, and 25 respectively. Later the fish learned not to attack the bait and even refused to eat the worms when they were placed free in the water.

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[2] K. Mobius, *Die Bewegungen der Thiere und ihr psychischer Horizont.*

[3] N. B. Triplett, "The Educability of the Perch," *American Journal of Psychology,* Vol. 12, p. 354 ff.

[4] H. Pieron, *Intelligence of Carassius.* See S. J. Holmes, *The Evolution of Animal Intelligence,* Henry Holt & Co., 1911.

Amphibia.—Amphibia are animals that live both on land and in the water. As a rule they possess gills in one stage of development and later lose these for lungs in the adult form. Even when lungs are developed many amphibians like the frog can live for several minutes under the water. These animals not only spend much of their time in or near the water but lay their eggs in the water.

The amphibians present a higher skeletal development than fish. They also have better sense organs and a more highly developed nervous system. In keeping with their other forms of evolution the musculature is more complex and better arranged for complicated movements.

In this chapter two amphibians will be studied. The frog is the most common and the best known of this class of animals. The amblystoma will also be studied largely because it has been made the subject of a very special study with considerable psychological importance.

The Frog.—The frog presents a very efficient, highly-developed, highly-organized structure. The skeleton is composed of a skull, vertebral column, pectoral and pelvic bones, and two sets of appendages, front and hind legs. The pectoral and pelvic arches and the two sets of limbs attached thereto present distinct steps in structural evolution. The digestive tract consists of a mouth, aesophagus, stomach, small and large intestine, with a liver, pancreas, and kidneys as accessory organs. There are three stages in the life history of the frog.[5] These are the egg, the tadpole, and the adult frog. Respiration in the tadpole stage is carried on through the gills, in the adult by means of lungs. The skin performs a large function in respiration in both stages. The circulatory system consists of a heart composed of one ventricle and two auricles, a system of arteries, capillaries, and veins.

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[5] The transformation from the larval or tadpole stage of the frog to the adult animal presents an interesting adaptation more complex but not essentially different from that of the insects. The tadpole develops from an egg. In metamorphosis it loses its tail and fins and changes from a gill to a lung breathing animal. These changes fit it for life not only in water but also on land.

The nervous system of the frog is composed of a brain, spinal cord, and sensory and motor fibers. The brain consists of a cerebrum, thalamus, cerebellum, and medulla. The olfactory lobes constitute a large part of the cerebrum. The cerebral hemispheres, which constitute the major portion of the brain of man, exist in the frog's brain as enlargements or outgrowths of the olfactory lobes. The optic lobes, the center for vision, which in man is part of the cerebrum, are separated from the rest of the cerebrum in the frog. They lie dorsal to (on top of) the thalamus. The medulla is relatively larger in the frog than in man and contains the centers for many reflex activities. Man has twelve pairs of cranial nerves while the frog has only ten.

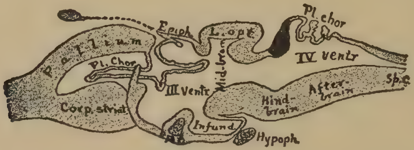

Figure 5. The Pallium and Cerebellum in the Brain of a Frog.
(The cerebellum is in black)

The sensory equipment of the frog is relatively complete. The eye is well developed. Whether colors can be discriminated except on the basis of brightness is not clear. The frog has an ear with the drums at the surface of the head. A single earbone extends across the middle ear. There is no cochlea. Yerkes[6] found evidence of response to the croaking of other frogs and the splashing of water but to no other sounds. This does not prove that the frog does not hear the other sounds. It may hear them and not respond to them. It has been found that the breathing rate was affected by sounds varying from 50 to 1,000 single vibrations per second. This indicates that the frog is probably sensitive to certain sounds at least. There is some indication of the presence of a sense of smell, but little evidence on the question is available. Frogs do select some kinds of food and reject others. We may infer that this selection is made on the basis of a true sense of taste. Common responses show that the senses of pain, pressure, warmth, and cold are present.

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[6] R. M. Yerkes, "The Instincts, etc.," *Harvard Psychological Studies*, Vol. 1, p. 627 ff.

Behavior of Frogs.—The behavior of frogs is rather complicated. Its reflexes are numerous and well developed. Considerable work has been done especially on decerebrated frogs to show the relative influence of cerebral and spinal controls. Even William James in 1890 spoke of the responses of the decerebrated frog, and pointed out that the casual observer is not easily able to distinguish between a decerebrated and a normal frog. The decerebrated frog will swim, strike at insects, hibernate, and make sex responses much like a normal cerebrated animal.

The classic illustration of response to acid placed upon the body or leg is well known. The response is a scratching reflex first by the nearest foot on the same side of the body. If this does not succeed in removing the noxious substance or if the stimulus becomes stronger or if the foot be held so as to prevent a response, the other foot on the same side responds. Stronger stimulation or a blocking of the response results in responses from the foot or feet on the opposite side of the body. This experiment shows the growth in complexity of response which may well be called coordination.

All these responses also show that the control of the spinal cord is much greater and of the brain much less in the frog than in the higher animals such as man.

The learning of frogs has not received extensive study. Yerkes found that frogs which were given an electric shock when they seized a certain kind of food refrained from eating any food for several days. It took about one hundred trials for a frog to learn a simple two-choice maze. There yet remains much to be learned about the behavior of amphibians. We know something of their hibernating, their feeding, and their breeding habits; but there has been relatively little study under carefully controlled conditions on the behavior of frogs other than that made by Yerkes.

The Amblystoma.—The amblystoma is another amphibian that has received considerable study. It is a salamander-like animal about three inches in length. There is little specialization of structure. The head is symmetrical. It has fairly well-developed vision, smell, and taste. The ear performs the double function of an organ of equilibrium and hearing.

The amblystoma reproduces by means of eggs which are deposited in large clutches. These hatch into small free swimming animals. Coghill[7] has made a study of the embryological development of the animal and the evolution of various behavior patterns.

Behavior of Amblystoma.—The first movement of the embryo is the turning of the head to one side. This is achieved by the contraction of the muscles in the neck region. The movement is slow. As the embryo grows older the muscle contractions extend further down the body until after about 36 hours the whole trunk is involved. The animal can now bend itself into a coil. The movement may be either to the right or left. The muscular contractions by this time have become rather rapid. The movement begins in the head region and progresses toward the tail. As yet locomotion is impossible.

However, it is only necessary for these movements to become alternate turnings from one side to another at a rapid or whip-like rate in order to cause forward progress in the water.

Coghill classifies these developments into five stages as follows: (1) non-motile stage; (2) early flexure stage; (3) the coil stage; (4) the "S" reaction; and (5) the "S" reaction with forward movement. He also found that nervous tissue was present in the amblystoma before movements began but there was no connection between the sensory and motor branches of the nervous system. While the muscles may respond to direct stimulation they will not respond to skin excitation at this stage.

Simultaneous with the appearance of true reflex activity a third set of neural cells develop. These are associative or connective cells uniting the sensory and motor fibers. They are located in the brain and cord. This development occurs first in the cerebral region and gradually extends tailwards. In other words the function of the musculature parallels structural development in the nervous system.

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[7] G. E. Coghill, *Anatomy and the Problem of Behavior,* Cambridge University Press, 1929.

A third stage of neural development consists in the growth of more branches in this connecting system and their passage to opposite sides of the body. This provides the physiological basis for swimming movements.

Following the development of swimming two other essential forms of behavior begin to evolve. Up to this point no feeding is necessary since the egg contains sufficient food to preserve life. When this food becomes exhausted the development of the mouth begins and with it the capacity to pursue, catch, and devour food. The legs have not yet developed. They are necessary for successful food getting and especially for locomotion on land. The fore limbs develop first. They lie near the sides of the trunk. Their first movements are flexion-extension. These movements in the beginning are performed only in harmony with trunk movements. Gradually the relation of trunk and limb movements diminishes and eventually the limbs move independently of the trunk. Here we may first speak of reflex limb movements. The hind limbs develop later and go through a period of gradual growth and freedom of movement. This occurs nearly two weeks after the growth of the fore limbs.

The first signs of walking consists in the animal raising itself on all four feet from which position it may fall forward. Later with a certain flexure of the body the corresponding limb is carried forward. With the reversal of flexure the opposite limb is carried forward. The movements of the body become rhythmical and locomotion results. It is to be noted that the limb movements are first made in harmony with trunk movements.

Coghill claims that walking consists essentially in slow swimming movements. While the neural development is not fully understood it seems to consist in further elaboration of the pathways already begun which form the basis of the swimming movements. In a similar way he shows the parallel in neural and muscular structure in gill movements and other feeding activities.

Coghill in these studies emphasizes the maturation of muscular and neural structure as the basis for the evolution of behavior. As the structures evolve, behavior results. He believes that neural growth does not cease at birth but continues relatively late in life. This growth does not consist in the formation of long fibers but in microscopic extensions within the brain and cord. This growth accounts for further developments in the learning process. Learning is not a passive but an active neural process. Here we have a very strong argument for the maturation factor in the Gestalt[8] theory of learning.

The Gestalt theory is further supported by the evolution of behavior. Coghill claims that behavior is unitary from the beginning. It is not made up of reflex parts but has organic unity from the beginning. As maturation proceeds this total pattern is broken up into smaller parts. Specific patterns are evolved from the total background of movements. This is the "quality upon a ground" of the Gestalt school.

While it must be admitted that the case seems strong for this point of view some psychologists remain skeptical. In fact, the case seems, if anything, too strong. Some question might be raised as to whether there may not have been some errors in the *interpretation* of the development of the amblystoma. Possibly such interpretations might have been read into the structural changes observed. Nevertheless the newer configuration school of psychology has a real contribution to offer to our theory of learning.

Reptiles.—Reptiles are a class of cold-blooded animals which include such animals as snakes, lizards, turtles, and crocodiles. They generally have short legs and crawl rather than walk. They are covered with scales. They are the highest class of the cold-blooded animals. Reptiles lay their eggs in secluded places and as a rule do not care for them but depend upon the heat of the sun to hatch them.

Behavior of Reptiles.—Not many controlled studies have been made with reptiles. The water turtle is the one animal in this group which has been studied extensively. There is considerable evidence that the turtle can see certain hues. Hess found that they did not eat food when illuminated by violet light. This he interpreted as evidence that they cannot see the shorter waves of the spectrum. The presence of red and orange globules which have been found in the cones of the retina may filter out the shorter waves in much the same way that visual purple in twilight vision in adults causes the Purkinje phenomenon.

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[8] See W. Koehler, *Gestalt Psychology,* Horace Liveright, Inc., 1929, and R. H. Wheeler, *The Science of Psychology,* T. Y. Crowell Co., 1929.

Yerkes[9] studied the ability of a turtle to learn a simple water maze consisting of six compartments and three inclined planes. It required thirty-five minutes the first time to get to the nest. There was an aimless wandering from point to point within each space and from space to space. By the fifth trial the turtle had learned the path fairly well. Of course, this represents very slow learning.

Much practical work has been done in the training of snakes. There is hardly a circus without its snake charmer. In many cases very clever things are done. However there may be considerable question how much of this training is training of the snake and how much of it is training of the charmer. In other words the snake charmer learns the characteristic behavior of the snake. He learns what the snake can do and what it will do under different circumstances. The charmer then controls the behavior of the snake by the control of his own behavior.

Why has so little experimental work been done with snakes and the other reptiles? That question is hard to answer. It may no doubt be partly due to the fact that reptiles as a class are not very acceptable companions for man. Even the early Bible story of creation mentions this fact. However, this aversion to the reptiles cannot be taken too seriously since the biologist and animal psychologist soon becomes immune to the prejudices and aversions of his youth and is willing and glad to study any animal form which shows interesting variation in form or structure.

Birds.—Birds possess several new structures which differentiate them from the reptiles. The chief characteristics of birds are that they are covered with feathers, they have wings for flight, they are warm-blooded, and they have a four-chambered heart.[10]

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[9] R. M. Yerkes, "The Formation of Habits in the Turtle," *Popular Science Monthly*, Vol. 58, p. 519.

Feathers are an evolution from scales which are characteristic of fish and reptiles. Feathers have a special value for flying. The long feathers of the wings and tail are particularly important and necessary for supporting the bird in the air.

Birds, as a rule, possess a horny beak, no teeth, and widely separated eyes viewing almost completely separate fields of vision. The bones of the body are closely fused together forming a rigid compact framework. Even the ribs are attached at either end making them immovable. Since the muscles that move the wings are mostly underneath there is a heavy breast with the characteristic rudder-shaped breast bone to which these muscles are attached.

Behavior of Birds.—The usual method of reproduction in birds is by laying eggs and hatching them by means of the heat of the body. While the laying of eggs is not different from reptiles the incubation by heat from the body of the parent and the subsequent care of the young is either not present in reptiles or at least carried on in a bungling and crude manner.

Birds possess considerable intelligence. They adapt themselves to varied conditions of living and as a consequence of this fact are to be found in all climates. Birds have from the earliest times provided man with a substantial amount of food both in the form of eggs and meat. These are no doubt some of the reasons why considerable experimental work has been performed on birds. These studies have been both anatomical and studies of the characteristic behavior and learning capacities of birds. Our interest will center in the latter problems rather than the first.

Even the briefest account of experiments in animal psychology would be incomplete without some mention of the work of Scott with Baltimore orioles, Conradi with English sparrows, Watson with terns, and Breed and Shepard with chicks.

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[10] It is to be understood by the reader that all the descriptions of different phyla, classes, and subclasses here given are descriptions of typical animals and that there may be several exceptions to the various descriptions within the different groups.

Scott[11] reared some orioles in isolation so that the young birds never heard the songs of adult birds. He reports that the song of his birds was quite different from birds brought up with wild orioles. Young males brought up with his birds developed the song of the confined birds. Scott used this same method on 15 or 16 different species of birds with similar results in each case. The robin, for example, had what he called an invented song. He found a yellow-breasted one which learned to imitate the postman's whistle so accurately that the experimenter was often deceived.

Conradi[12] reared young English sparrows with canaries and found that at first they gave the characteristic sparrow chirp but later developed a fair canary repertoire. The sparrows were then placed with normal sparrows and soon took up the sparrow chirp. When returned later to the canaries they readapted themselves to the canary song. It is only to be regretted that this experiment has not been repeated on a wholesale basis.

Breed and Shepard[13] studied the development of the pecking instinct of young chicks. They counted the number of times the chicks were able to pick up and swallow grains of food out of fifty attempts. On the second day after hatching, without previous experience, the chicks were able to make a successful response in 17.4% of their trials, on the third day 58.0%, on the seventh 73.4%, and on the sixteenth day 86.4%. Other chicks were kept in the dark and fed artificially. On the fourth day they were fed grain for the first time and were 10% successful. On the next day their success increased to 64.0%. Similar gains were made by chicks fed artificially and then begun on normal feeding after longer delays. The general results from the experiment show that whenever the chick starts, his initial performance is of about the same degree of accuracy, but the chicks that start later gain more rapidly and soon catch up with the ones that began feeding earlier. This experiment shows rather conclusively that both practice and maturation had a part in the process. The chicks that started later began no better than the younger chicks, but they progressed more rapidly after starting. Considerable practice was necessary before the two groups were equal. Equality resulted only after those starting later had completed the necessary practice period and those starting first had almost reached their physiological limit.

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[11] W. E. D. Scott, "Songs in Birds," *Science* (1901), Vol. XIV, p. 522; "Data on Songs in Birds," *Science* (1902), Vol. XV, p. 178; "The Inheritance of Song," *Science* (1904), Vol. XIX, p. 154.

[12] E. Conradi, "Song and Call—Notes of English Sparrows When Reared by Canaries," *American Journal of Psychology* (1905), Vol. XVI, p. 190.

[13] F. S. Breed and J. F. Shepard, "Maturation and Use in the Development of an Instinct," *Journal of Animal Behavior,* (1913) Vol. 3, pp. 274–285.

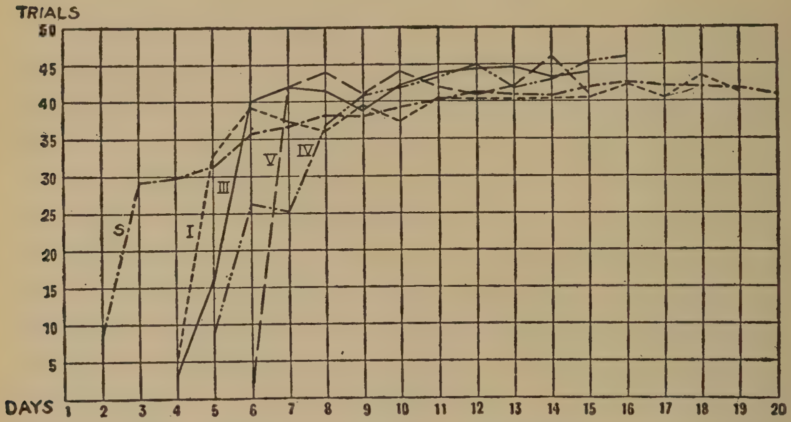

Figure 6. Curves Showing the Course of Development of the Pecking Instinct After Artificial Delay

S, standard curve, representing rate of improvement in accuracy under natural conditions. I, III, IV, and V, curves for corresponding groups of chicks in which the action of the instinct has been artificially prevented for one, three, four, and five days, respectively, previous to the first tests.

(Breed & Shepard, *Journal of Animal Behavior,* 1912, p. 278)

Watson studied two species of tern on the West India Islands. Besides studying their behavior in their natural habitats, he took some of them long distances across the ocean. In a relatively short time most of these birds arrived back at their nests. Man placed under similar circumstances upon the uncharted seas without a compass would be hopelessly lost. In some manner which we are not able to understand these birds were able to find their way back.

Mammals.—Mammals are animals that possess a mammary gland in the female which is capable of producing food for the young. This capacity marks a distinct advance of a kind.

Animals that lay eggs which contain food material in addition to the germ cells provide food for the growing animal for a short time after hatching. Thereafter food must be secured by parents or the offspring itself. In viviparous animals, as almost all the mammals are, the egg is retained within the womb of the mother and fed from the mother's blood stream. After birth food is provided by the mammary gland. This provides a sure source of food of good and uniform quality. While such a supply of food from the mother may be somewhat of a handicap to her, it increases several fold the probability of life for the offspring.

Behavior of Mammals.—More studies have been made upon mammals than on all the rest of the animal kingdom combined. Many volumes have related the anecdotal stories, the semi-scientific accounts, and the controlled experimental findings on this group of animals. These studies include the dancing mouse, the white rat, the guinea pig, the cat, the dog, the raccoon, the monkey, the ape, the chimpanzee, and many other animals. Even a brief summary of all these experiments would extend beyond the limits of this volume. The field of animal or comparative psychology, including the psychology of the higher primates, is no small branch of the general subject matter of psychology.[14] Suffice it here to consider some of the more important studies in this field.

The Dancing Mouse.—Yerkes, who made an extensive study of the so-called dancing mouse, found that it could distinguish red from green. It could not distinguish between different forms and shapes. He found no tendency for one mouse to imitate the actions of other mice. Mice one month old learned to discriminate colors better than older mice. This evidence is in line with some much more recent experiments which seem to show that younger animals learn motor skills more readily than older animals. This probably corresponds to the "athletic" age in man. Yerkes found that all the mice retained the training for color discrimination two weeks and some for as long as four and six weeks. All had forgotten at the end of ten weeks.

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[14] The student who is interested in this problem is referred to the following texts for a fuller treatment of the topic: J. B. Watson, *Behavior—An Introduction to Comparative Psychology*, Henry Holt & Co., 1914; Margaret Washburn, *The Animal Mind* (3rd ed.), The Macmillan Co., 1926; R. M. Yerkes and B. W. Learned, *Chimpanzee Intelligence*, Williams & Wilkins Co., 1925; E. L. Thorndike, *Animal Intelligence*, The Macmillan Co., 1911; Wolfgang Koehler, *The Intelligence of Apes*, Harcourt, Brace & Co., 1924.

The White Rat.—Many studies have been made upon the white rat. The rat has been used especially in the study of learning, most of the experiments being made upon the learning of a maze.[15] Carr,[16] Watson, and others[17] have studied the use of the different sensory cues by white rats in learning a maze. Vision, smell, tactual (through the vibrissae, and through the soles of the feet), kinaesthesis, air currents, and temperature changes were studied.

Rats were taught to run the maze in the dark. The eyes were removed from two other groups of rats. In each case these rats were able to learn the maze as rapidly as normal rats in daylight.

While these experiments show that vision is not essential to learning in the white rat, they do not prove that under normal conditions the rat does not use vision at least to some extent. Vision may reasonably be considered as a secondary feature, not necessary, but probably used in ordinary situations. Vision may actually be of more service to the rat in its everyday life than these experiments would indicate. Observation shows that the rat like many other animals is much more sensitive to movements within his visual field than to stationary forms. The rat can see objects move and thereby may be able to escape danger by using the vision they have despite the fact that vision is poor and that what they have is not necessary in learning an ordinary maze.

In order to study the significance of smell in learning, odors were placed along the right pathways in a maze and rats were permitted to run the maze by the odor. In another experiment the olfactory bulbs of a group of rats were removed and after recovery from the operation these rats were able to learn a maze just as rapidly as normal rats.

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[15] Watson, *op. cit.*, Ch. VI.

[16] H. A. Carr, "Maze Studies with the White Rat," I—Normal Animals, II—Blind Animals and Anosmic Animals, *Journal of Animal Behavior,* (1917) Vol. VII, pp. 277–295. Also H. A. Carr and J. B. Watson, "Orientation in the White Rat," *Journal of Comparative Neurology and Psychology,* (1908) Vol. XVIII, pp. 27–44.

[17] S. B. Vincent, "The White Rat and the Maze Problem: Visual, Olfactory and Tactual Control," *Journal of Animal Behavior,* (1915) Vol. V, pp. 1–24, 140–157, 175–184. Also R. M. Dorcus and W. L. Gray, "The Rôle of Kinaesthesis in Retention by White Rats," *Journal of Comparative Psychology,* (1932) Vol. XIII, pp. 447–457.

The direction and intensity of air currents were studied as well as changes in temperature of the air in the *cul de sacs* (blind alleys) and no noticeable effects on the rate of learning were noted. Likewise the effect of a local anesthetic on the soles of the feet was not noticeable in the learning process.

The effect of kinaesthesis has also been studied. A maze composed of four quadrants was cut into four parts and the quadrants shifted after a group of rats had learned the maze. The rats proceeded to try to make the turns where turns had existed in the first form of the maze and they tried to go straight ahead where the new turns were placed. This seems to show that the rats had learned to run the maze by the "feel" of the runways. When these old pathways were broken up the rats had to relearn the maze. The rats ran the maze much as a person climbs a stairs in the dark, generally knowing the end of the steps even if he has not counted them. However, some recent work by Dorcus and Gray makes them question kinaesthesis as so all-important in maze learning. Of course, as has been indicated, the rats may use vision or they may use tactual, auditory, olfactory, or some of the other senses as secondary or guiding cues when possible, but when deprived of any one of these secondary cues they can run the maze just about as efficiently as when they are used.

The series of experiments that has added much to our knowledge of brain functions and dissipated many traditional notions about brain localization has been conducted by Lashley.[18] Using both rats and monkeys he has extirpated various parts and amounts of the brains of these animals. In these studies he has used two types of experiments. In one type he had already trained the animal in some sensory discrimination or to run a maze. Lashley then studied what effect the removal of certain parts of the brain had upon the abilities which had been acquired. In cases where the functions were lost through the operation he studied whether the abilities could be acquired again and if so the rate of reinstatement of the function as compared with normal rats.

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[18] K. S. Lashley, *Brain Mechanisms and Intelligence,* University of Chicago Press, 1929.

In the other type of experiment he removed various brain areas of untrained rats and determined whether certain normal abilities could be acquired and if so the rate of acquisition as compared with normal rats.

Lashley's results refute much of the older doctrine concerning cerebral localization. His results may be briefly summarized as follows:

1. The ability to learn a maze is reduced by the removal of any appreciable amount of brain tissue. The amount of the loss is directly proportional to the amount of brain tissue removed. It makes little difference from what part of the brain the tissue is removed. It is the amount and not the part removed that is significant.

2. The more complex the problem to be learned the more serious the effect of the removal of any amount of brain tissue. In certain very simple problems the removal of a very small amount of brain tissue in the rat resulted in a slightly more than normal rate of learning. One possible explanation for this fact may be that the removal of a small amount of brain tissue reduces the "cerebral inhibitions" resulting in an increase in learning rate for simple problems. In the more difficult tasks the removal of any amount of brain tissue resulted in a loss of ability.

3. The effect of a brain injury has an influence on abilities already learned directly proportional to the extent of the injury. It made little difference what area was destroyed. In other words a slight injury to any part of the brain tended to interfere with any ability the animal had learned. The more serious the injury the greater was the loss in the ability.

4. The same general results were obtained with the different mammals studied. An examination of the literature in this field, contrary to the usual opinion concerning the subject, Lashley says, indicates similar findings. This includes those studies dealing with brain injury in man as well as in other mammals.

In his experiments Lashley destroyed all possible association pathways and yet did not interfere with functions supposedly dependent upon the pathways concerned. These results lead him to believe that the brain does not function as a series of "reflex arcs" but that it functions somehow as a whole or at least in patterns. In other words, distinct pathways in the brain do not exist but brain activity consists in regional, pattern, or total activity.

Before fully accepting all the implications of these studies it should be remembered that whenever the brain or any part of it is destroyed its normal functions may be destroyed. Whether or not an injured brain functions the same way as a normal brain we do not know. There is no assurance that it does. In other words the operations performed by Lashley may have produced an abnormal type of brain function. However, we do not know that such extirpation produced abnormal functioning; it may not.

Again it should be noted that in some of his later work Lashley has found evidence of some differentiation in brain functions. Certain brain areas appear to be essential for some of the higher discriminatory functions such, for example, as that of the perception of geometrical forms. It may be that it will be found that there is more to the theory of brain localization than Lashley's earlier work indicated. Yet it does seem certain that many of our older doctrines were based upon insufficient and misleading evidence and that there is not nearly so much to these doctrines as we had supposed.

Imitation in Animals.—Thorndike[19] performed a number of significant experiments on dogs, cats, and other animals to determine whether animals *imitate* each other and whether they have ideas and employ reason. He studied the learning of animals in getting out of pens and cages. Two hungry cats were placed in a cage with a latched door and a fish was placed outside the cage. One cat was fastened within the cage and the other was free to get out. The free cat, after trying to crawl through the lattices and attempting various other means of escape, finally hit upon the right method and freed itself. When it was returned to the cage, it went through much the same procedure, but some of the useless movements were eliminated and it got out in a shorter time than on the first trial. The cat was placed in the cage several times and gradually learned so that for the last few times it escaped almost immediately. The second cat was then released in the cage to see if it had profited by the experiences of the first cat. It was found that the second cat took just as long to learn to get out of the cage as the first cat. There was no learning by imitation. Other animals were tried always with similar results.

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[19] E. L. Thorndike, "Animal Intelligence," *Psychological Research Monograph Supplements,* (1898) Vol. 2, No. 4; also *Animal Intelligence,* The Macmillan Co., 1911.

How Animals Learn.—In a study of the learning curves of animals Thorndike found that improvement is gradual and not sudden. If the animals solved problems by the use of ideas or reasoning, the improvement, when it came, would have been sudden. We find such sudden improvement in human learning in solving puzzles and problems. On the other hand, in trial and error learning in human beings the learning is gradual, as Bryan and Harter[20] found in telegraphy and Book[21] and Swift[22] found in typewriting. The learning of animals is like this and hence Thorndike infers that it is of the trial and error type. He explains it on the basis of the association of sense impression and impulsion. He rejects reason, comparison, or inference, perception of similarity, and imitation. He has denied the existence of animal consciousness, of any important stock of free ideas, or impulses as "unnecessary." [23]

Thorndike also studied the learning of monkeys. He summarizes his findings as follows:

> Monkeys represent progress in animal development from the generalized mammalian type toward man:
>
> 1. In their sensory equipment, in the presence of localized vision.
> 2. In their motor equipment in the coordinated movements of the hand and eye.
> 3. In their instincts of inherited nervous connections, in their general physical and mental activity.

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[20] W. F. Bryan and N. Harter, "Studies in the Physiology and Psychology of the Telegraphic Language," *Psychological Review*, (1897) Vol. IV, pp. 27–53; (1899) Vol. VI, pp. 348–375.

[21] W. F. Book, *The Psychology of Skill of Learning to Typewrite*, Gregg Publishing Co.; published in Psychological Bulletin No. 53, Psychology Series No. 1, University of Montana.

[22] E. F. Swift, *The Mind in the Making*, Charles Scribner's Sons, 1908.

[23] E. L. Thorndike, *Animal Intelligence*, The Macmillan Co., 1911.

4. In their method of learning or association processes; in
    - (a) Quicker formation of associations
    - (b) Greater number of associations
    - (c) Greater delicacy of association
    - (d) Greater complexity of association
    - (e) Greater permanence of association

He states further:

> . . . the only demonstrative intellectual advance of the monkeys over the mammals in general is the change from a few, narrowly confined, practical associations to a multitude of all sorts, for that may turn out to be at bottom the only *demonstrable advance of man,* an advance which in connection with a brain acting with increased delicacy and irritability, brings in its train the functions which mark off human mental faculty from that of all other animals.

Thorndike's point of view is not held by all psychologists. Cole[24] studied raccoons and found evidence of learning by being put through a performance. This Thorndike did not find. Cole presented a series of white, blue, and red cards as signals for food. When three red cards were presented in succession no food was given. When white, blue, and red were presented in succession food was given. The raccoon learned these signals. Cole says,

> Each one, on seeing the first red card would drop down from a position with both front paws on the front board to stand on all fours in front of it, and merely glance up at the succeeding reds, but as soon as the white appeared, however, the animals would lean up against the front board, claw down the white and blue, but never the final red.

Cole thinks this is evidence that the animal retains an image of the cards which immediately preceded the red. Berry found what he thought was evidence of a very simple kind of imitation by the white rat. Davis also found evidence of ideas in raccoons. Hunter,[25] working with raccoons, thought he found evidence of a memory idea. Haggerty[26] thought he found evidence of imitation in monkeys. Lloyd Morgan[27] believes that animals manifest certain types of reasoning. In closing this argument we should again mention that the differences here found are differences in *interpretation* of the results and not differences in the results themselves.

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[24] L. W. Cole, "Concerning the Intelligence of Raccoons," *Journal of Comparative Neurology and Psychology,* Vol. 17, p. 193.

[25] W. S. Hunter, "The Delayed Reaction in Animals and Children," *Behavior Monographs,* Vol. 2, No. 1, Serial No. 6.

[26] M. W. Haggerty, "Imitation in Monkeys," *Journal of Comparative Neurology and Psychology,* (1909) Vol. XIX, p. 337 f.

Chimpanzees.—Yerkes and Learned [28] studied two young chimpanzees, Chim and Panzee, for several months on a farm in New Hampshire and later in a cage in Washington. Yerkes devotes some time to a discussion of the mental traits of these animals and then proceeds to give "evidence of insight." This consists partly in observations of imitations and intelligent behavior and partly by more or less controlled experiments. One of the latter consists in securing a banana placed above the reach of the animal. In order to reach the food the animal had to stack three boxes one on top of the other and climb on top of them. After several unsuccessful attempts Chim reached the banana. Panzee never exhibited enough intelligence to secure the food.

Yerkes attempted to train Chim to use certain words in asking for food. The results were very discouraging. Miss Learned attempted to teach the chimpanzees some simple musical tones, with similarly unsuccessful results. Language and tone qualities are beyond the learning capacities of chimpanzees.

W. Koehler[29] spent four years in the study of chimpanzees in Teneriffe, Canary Islands. He made careful observations of the animals in their natural habitats. He also subjected a number of the chimpanzees to careful observation and experimentation. His studies led him to criticize severely Thorndike's point of view. Koehler found evidence that the chimpanzee lives "not only in the past but in the future." He points out that one of the apes made nine out of ten correct responses in the perception of size after an interval of thirteen months. Nor was this an exceptional performance. As evidence that chimpanzees have ideas, Koehler presents the results of an experiment in which he hid some bananas with the animals watching him. Although the place of hiding in the sand was so well concealed that the experimenter could not locate the spot, the chimpanzees after sixteen and a half hours were able to locate and dig up the food with few errors. That the bananas were not located by smell he claims is certain because of the chimpanzee's poor sense of smell.

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[27] C. L. Morgan, *Animal Life and Intelligence*, Ginn & Co., 1891.
[28] Yerkes and Learned, *op. cit.*
[29] Koehler, *op. cit.*

The securing of food and storing of it rather than eating while others were taking food from a common source, Koehler thinks, indicates a preparation for future needs and not just a manifestation of the hoarding instinct.

The group life of chimpanzees, their common defense against enemies, their fear of strange animals and objects, even of "false faces" and a small toy donkey, he takes as evidence of a high degree of intelligence. He gives intimate examples of devotion (love?) to himself as the result of the care they received. One or two of his animals even protected him against the attack of the rest of the group some time after he had especially befriended them.

The Experimental Method of Animal Study.—From all this account it is very evident that Koehler holds a very anthropomorphic view of his animals. Furthermore, he no doubt would agree with Holmes[30] in his criticisms and in pointing out the limitations of the classical experimental methods in the study of animals.

> Until quite recently most of our knowledge of the psychology of mammals, as of other animals, was obtained simply by observation. In this way has been accumulated a large fund of information concerning their instincts and habits, and to a certain extent their intelligence. But in this, as in other fields of investigation, the method of experiment has come to be indispensable when the attempt was made to study the phenomena analytically. There is, of course, no special magic in the experimental method; it is simply a means of improving the means of observation. And in animal psychology especially, the method may have drawbacks which counterbalance some of its advantages. The labyrinth and puzzlebox devices of our psychological laboratories have the advantage of enabling us to study animal behavior under strictly controlled conditions and they readily yield results in a form capable of easy tabulation, but these methods have been criticized with a certain measure of

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[30] S. J. Holmes, *The Evolution of Animal Intelligence,* Henry Holt & Co., 1911, pp. 232–234.

justice on the ground that the artificial conditions to which the animals are exposed make them appear more stupid than they really are. A fox in its wary prowlings for prey or in its attempts to outwit its pursuers may manifest a considerably higher degree of intelligence than it would show if confined to a box from which it had to liberate itself by fixing levers and pulling belts. In wild animals especially there is a falling off of spirit and initiative when they are placed in an artificial environment. The lion of the desert is a very different creature from the lion of the circus; the keenness and alertness with which the one conducts his hunt for prey stand in marked contrast with the melancholy and reluctant performances of the other when under the trainer's whip. Other animals such as raccoons and some monkeys take to a life of confinement much more readily, and therefore afford particularly valuable subjects for experiments. Those experiments are of the most value which stimulate to the greatest extent the free exercise of an animal's faculties, and in order to secure this result an animal's instinctive interests and promptings should be given, so far as possible, free play.

The experiments of the last few years have given us a more just estimate of the nature and limitations of the intelligence of the higher animals than we formerly possessed. Animal psychologists have come to scrutinize their results much more closely and to be more cautious in their statements regarding what goes on in the mind of the animal studied. The interpretation of what mental processes are involved in most animal performances is a matter of much difficulty. We may be guided on the one hand by analogy with ourselves, which leads us to infer that actions similar to our own are accompanied by similar mental states; and by the law of parsimony on the other hand, which bids us to assume the existence of higher mental qualities of the phenomena can be explained in terms of simpler mental processes. In the imperfect state of our knowledge these two guides often lead to opposed conclusions. If we applied the principle of Morgan to the psychology of our fellow human beings we should be continually led astray. So in our interpretations of the psychology of the higher animals we may very frequently be "missing it" more or less widely in our adherence to this principle. The antecedent probability in favor of not giving the animals the benefit of the doubt diminishes as we ascend the scale of psychic life. We may suspect that our interpretations "fall short," but our opinions cannot be said to rest on a secure basis until we are able to support them by experimental proof. The principle of Morgan affords a check to the natural tendency toward "anthropomorphism" which is a common human failing; it throws a burden of proof on whomsoever attempts to establish the existence in animals of higher faculties and if the positive conclusions to which it permits us to come fall short of the truth we can at least rely on them so far as they go.

From these descriptions and discussions we see examples of the two different points of view regarding the mentality of animals, particularly of the higher animals, excluding man. Do they have ideas and think somewhat as human beings? One group of experimentalists, for example Koehler, says they certainly do. Another equally renowned experimenter, Thorndike, says he thinks they do not. Which is correct? We do not know. Our point of view as a scientist leads us to favor the point of view of Thorndike, not so much because we think it is the most probable but because we think it the most likely to lead more nearly to the truth of the matter. Science is skeptical until proof is forthcoming. If Thorndike and Watson can find a satisfactory explanation of events without the use of mental elements they have made a real advance. But it must be noted that in each case the differences in the two schools has not been in the facts they have discovered but rather in interpretation they have placed upon these facts.

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CHAPTER 5

PREHISTORIC MAN

Man's Relation to Other Animals.—Our major interest all along in this account has been in the development of those characteristics which are distinctly human. In this chapter we shall be particularly concerned with the immediate background and early history of man. In this discussion it will be necessary to consider the sources from which man developed, his relation to the other animals of his time and the geological and other factors which affected his development.

Darwin, of course, was the person who first called special attention to the relation of man to the other animals. His doctrine of evolution has completely dominated the thinking of modern biologists. According to this point of view man is classed as a mammal. He is further classified as belonging to the order called primates.

This order possesses several distinct advances over the lower orders of mammals. They have good vision. In the primates the two eyes are situated near each other and are so located that they have almost but not identical fields of view. This is called stereoscopic vision. Such vision is essential to the perception of form and especially to distance. Most of the primates live in trees. Stereoscopic vision permits them to estimate carefully the distance between branches and also their distance from enemies both on trees and on the ground. Such vision is of further advantage in locating and securing food.

Another important feature of the new structures of the primates is the opposition of the great toe with the rest of the foot (or as in the higher forms, of the thumb from the fingers in the upper limbs). Along with this is found a greater flexibility of the feet. Instead of claws the toes are generally provided with nails. Such feet are useful both in climbing trees and in walking upon the ground. The fore feet of these animals are also used in securing and holding food. The new form of foot has a decided advantage not only in clawing the food from trees but also in holding it while eating the portions which they like.

Correlated with the development of stereoscopic vision and better feet are two corresponding brain developments. These consist in the enlargement and enrichment of the visual and tactual areas of the brain. Below the mammals there is practically no cerebrum except the olfactory lobes. With the substitution of vision for smell we find a shift from the dominant olfactory lobes to the visual areas of the brain. The area of the brain for the tactual sense is located in the parietal lobes. Therefore the development of the visual area in the occipital lobe and the tactual in the parietal lobe presents a new brain form which is distinctly human in character.

The Primates.—But man is only one of the primates. This order includes monkeys, lemurs, tarsiers, and the anthropoid apes. The principal anthropoid apes are the gibbons, orangs, chimpanzees, and gorillas.

The chief advances of the anthropoids over the lower primates are longer upper limbs, a better hand, more erect posture, and a curved spinal column. Although primarily arboreal, most of the anthropoids occasionally come to the ground. When in the trees the fore legs are used for hanging from the limbs. This results in a more erect posture even while in the trees.

Some other characteristics which show the close relation of the anthropoids to man but which can hardly be called advances are the development of a vermiform appendix; red blood cells similar to man, a susceptibility to many of man's diseases, such, for example, as tuberculosis and a similar menstrual and gestation period.

However, there are some marks of difference between the anthropoid apes and man. Man has lost much of the furry covering common to the anthropoids. Man walks erect. He has no muzzle and has developed a chin. His spine is more highly curved and his limbs are straighter. Man has a wider

TABLE I. GEOLOGIC AGES AND THEIR RELATION TO LIFE

MAJOR PERIODS		PERIODS	EPOCHS	RACE OR TYPE	
Holocene		Modern	Post Glacial	Modern Races	Age of Man
Quaternary		Pleistocene	Fourth Glaciation	Cro-Magnon Man	
			Third Inter-Glaciation	Neanderthal Man	
			Third Glaciation		
			Second Inter-Glaciation	Piltdown Man Heidelberg Man	
			Second Glaciation		
			First Inter-Glaciation		
			First Glaciation		
Tertiary	Late	Pliocene Miocene		Pithecanthropus	Age of Mammals
	Early	Oligocene Eocene Paleocene		Rise of Anthropoid Forms Specialization of Mammals Rise of First Mammals	
Mesozoic	Late	Cretaceous Comanchian		Specialization of Reptiles Rise of Flowering Plants	Age of Reptiles
	Early	Jurassic Triassic		Rise of Birds Rise of Dinosaurs	
Paleozoic		Permian Pennsylvanian Mississippian Devonian Silurian Ordovician Cambrian		Dominance of Fishes Luxuriant Vegetation	Age of Fishes
Proterozoic				Simplest Plant and Animal Life	Age of Invertebrates Dawn Age
Azoic (Archaeozoic)				Largely Without Life Possibly Life Originated	Lifeless Age

pelvis. He does not have the great toe opposed to the rest and he has a much more developed hand. Furthermore, he has a larger and better brain.

What, then, is man's relation to the anthropoid apes? Is he a direct descendant of one of them, or are they both the offspring of some common but extinct parent? Is there a so-called "missing link" between man and the apes, or is the missing link rather a missing common parent? The answer to this question is fairly certain. Man is not a descendant from the apes. There is some question as to just what the common parent was. MacCurdy[1] and Romer[2] mention the small Asiatic tarsius as the modern form most like the early common parent. It is also probably true that the early man-like forms soon to be described were not man's progenitors but were offshoots from the family tree that flourished for a time and then became extinct.

Geological Background of Life.—Before tracing this development it will be worth our while to give a brief consideration to the geological background into which man fitted his life. From the accompanying table some idea of the geological ages and the corresponding life cycles can be obtained. (See Table 1.)

Probably life has not existed on the earth except for a relatively short part of the earth's history. The earliest era, the Azoic (sometimes called the Archaeozoic), was a long era, probably the longest of all. We do not know whether life existed during any of this era or not. It probably developed during the latter part of the era or the beginning of the following era.

During the second, the Proterozoic era, life was beginning to develop into complex forms. However, it was probably not until the next, the Paleozoic era, that the first vertebrates were to be found. Later came the reptiles, birds, and, finally, the mammals. This occurred in the early Tertiary era. It was at least not until the late Tertiary that the first man forms appeared. The oldest prehistoric specimen (Pithecanthropus erectus) is variously assigned to the Miocene, the Pliocene, and the Pleisto-

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[1] G. G. MacCurdy, *Human Origins,* D. Appleton & Co., 1924, Vol. I.

[2] A. S. Romer, "The Evolution of the Vertebrates" in *The Nature of the World and of Man,* University of Chicago Press, 1927, Ch. XI.

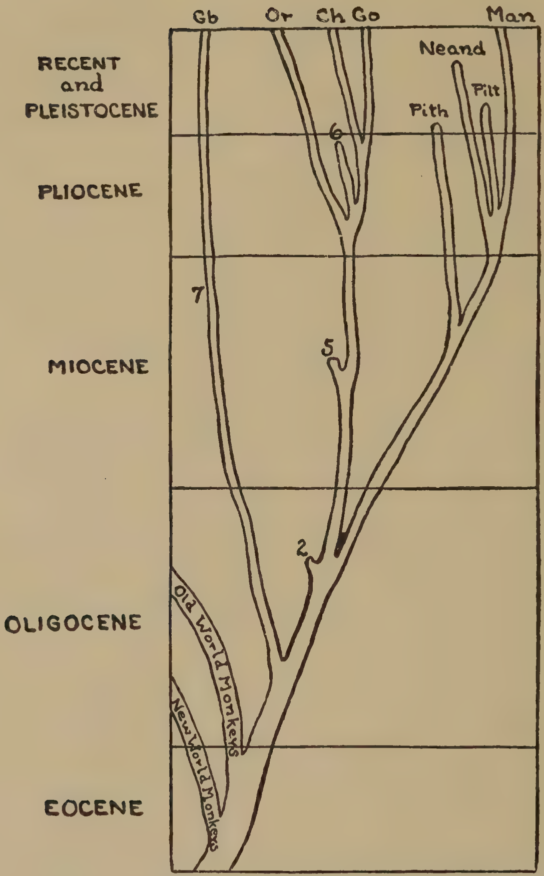

Figure 7. The Descent of Man in Detail, According to Keith (somewhat simplified)

Extinct forms: 2, Propliopithecus; 5, Dryopithecus; 6, Palaeopithecus; 7, Pliopithecus; Pith(ecanthropus), Pilt(down), Neand(erthal). Living forms: Gb, Gibbon; Or, Orang; Ch, Chimpanzee; Go, Gorilla.

(A. L. Kroeber, *Anthropology,* Harcourt, Brace & Co., 1923) cene periods. The first two of these are in the Tertiary era, and the last is in the Quaternary era.

The Quaternary was the era of the ice sheets. There were four different epochs during which ice covered most of Europe and much of North America. Between each of these there were epochs in which the climate was relatively warm. In these epochs plants and animals flourished in what is now the temperate zone. With the approach of another ice sheet the plants died and most of the animals were driven to warmer climates to be supplanted by those provided with coverings to withstand the extreme cold.

It has been claimed by many that the second and third oldest man forms were developed during the third interglaciation and another during the fourth glaciation. As has already been said these forms developed, lived for a few hundred or possibly thousand years, and then became extinct. It is not unreasonable to assume that the coming of subsequent ice sheets had much to do with the extinction of these prehuman forms. It was not until after the fourth glaciation that modern man appeared in Europe. Whether he developed somewhere in a warm part of Asia during or preceding this last glaciation and then migrated into Europe we do not know.

The Arrival of Man.—How far back must we go to get the earliest parts of the story of man's life upon the earth? Although there is great difference of opinion, it may be roughly estimated that from half a million to a million years have elapsed since the first man forms appeared on the earth. There are two main reasons for the indefiniteness of this date.

First, it is difficult to determine to just what stage of development the term man is to be applied. Certainly the process of evolution was a slow, gradual one. First one characteristic and then another appeared. It is a matter of definition as to how many of these characteristics are necessary to constitute man. This is one reason for the disagreement among writers as to the antiquity of man.

Second, it is very difficult to measure geological time accurately. The chief methods for making these estimates are:

(1) On the basis of the amount of sediment that has been deposited since the first evidences of man's existence. Although the amount of deposit can be measured fairly accurately, we cannot be sure about the rate at which the sediment was deposited. To infer that it was at the present rate may lead us far astray. (2) From the animal remains with which these first signs are associated. But even if these associations are established we can only estimate the age of these associated animals. (3) By the changes that man himself has undergone. Here again we can only guess at the time required for a change in skull shape, a greater curvature of the spine, etc.

Although we may disagree as to the time of man's first appearance upon the earth, there are two lines of evidence from which we can learn something about him. The first of these is from the study of the remains that have been discovered, and the second is from the tools and other materials which have been found either associated with these remains or found elsewhere, but bearing incontestable evidence of the work of man. As has already been indicated, these lines of evidence are fragmentary. They are, nevertheless, unmistakable, and they tell us a wonderful and fascinating story.

By the use of the methods just described, considerable information concerning modern man's earliest near relatives has been discovered. This evidence has come from various parts of the earth. Most of it, as we shall see later, has come from Europe. This is not necessarily because early man made that his principal home but because Europe has been more carefully studied than any other part of the world. However, it is significant that there is clear evidence for the presence of man-like apes or ape-like men in China, India, Africa, and Europe. Within the last few years a fossilized brain of characteristically human type has been taken from near the middle of an eighty-foot cliff in South Africa. The better-known specimen of the oldest prehistoric man came from the East India islands. China has recently made her contribution in the form of some very primitive human fossils. It is probably significant but, nevertheless, difficult to explain that some such specimens have not been found in either of the Americas.

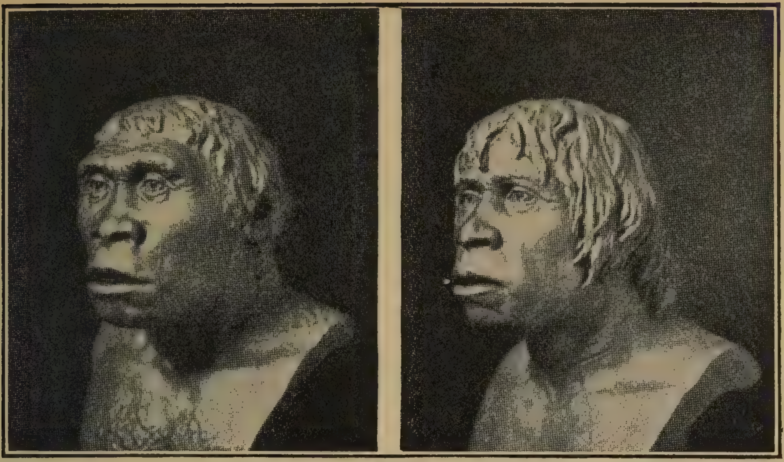

Figure 8. Java Man (*Pithecanthropus erectus*) and Piltdown Man (*Eoanthropus dawsoni*)

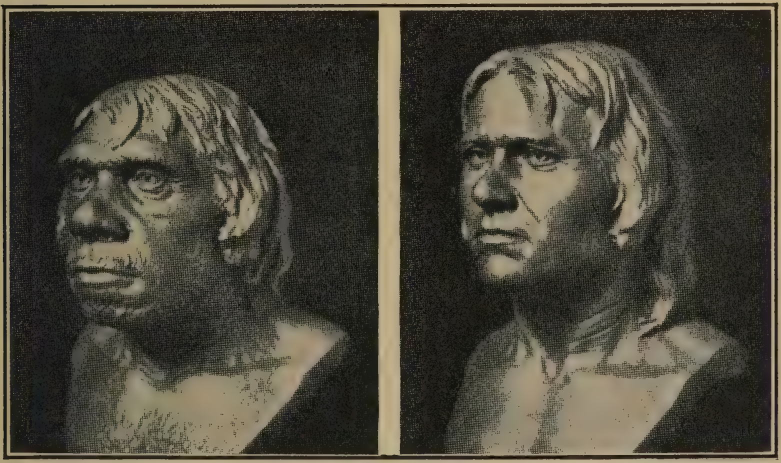

Figure 9. Neanderthal Man (*Homo neandertalensis*) and Cro-Magnon Man (*Homo sapiens*)

(These and the above heads modeled by Professor J. H. McGregor)
(R. S. Lull *et al., The Evolution of Man,* Yale University Press, 1922)

Let us now briefly review some of the better-known evidence concerning these early man forms and what we know about their civilization.

Pithecanthropus Erectus.—In 1891 there was discovered on the island of Java what probably are the oldest human or near-human remains. These consist of a skull cap, three teeth, and a left femur. From such remains we may learn many things about this primitive man. If we had to be limited to such a small collection, the parts could hardly have been better chosen. From the skull cap the shape of the head and the size of the brain can be fairly accurately determined. The cranial capacity of this first man, known as Pithecanthropus, was 800 to 1,000 grams, while that of modern man is approximately 1,500 grams. The frontal region, which is possibly especially concerned in the formation of new associations or learning, in Pithecanthropus was relatively small.

The accompanying figure gives one author's conception of how Pithecanthropus looked. It is not known whether he had any sort of language. Some one has suggested that his mouth was not properly shaped for speech.

The skeletons of three species of elephants, the hippopotamus, and the wild boar, as well as many other animals now extinct, were found in the same geological stratum with Pithecanthropus. The remains of no living species of animals were found in this region. Pithecanthropus has been assigned by some to the Miocene and by others to the Pliocene and by still others to the Pleistocene period. The date has been variously estimated from a half million to a million years ago.

Heidelberg Man.—In the year 1907, not far from the city of Heidelberg, Germany, the jawbone of another specimen of early man was found. This specimen has been called the Heidelberg man. Although only the lower jaw has been discovered, it is an unusually perfect specimen. The teeth indicate that the mammalian forms are further developed. The shape of the jaw, heavy and linear with no chin, indicates that this was truly a transitory man, with closest relationship to his successor, Neanderthal man. His age has been placed by Lull at about 400,000 years.

Associated with the remains of this Heidelberg man were flints which give clear evidence of having been chipped or shaped for use. Instead of taking for his use whatever he found, this man began adapting what he found. This was never true with the apes. These earliest crudely shaped stones are called Eoliths. This step marks the Heidelberg man as truly different from the other ape forms.

Piltdown Man.—What appears to be the next step in our history of man's development was discovered at Piltdown in Sussex County, England. The Piltdown skull was discovered by an unknown workman while digging a road. The skull was shattered by the workman's pick, and all that remains are the fragments of a skull and parts of a jaw with a few teeth in place. Another specimen almost as fragmentary has since been found only a few miles from the first. The work of restoration has been very difficult.

It seems that the brain of the Piltdown man weighed something over 1,300 grams, or almost as much as that of modern man. While the jaw protrudes it does not protrude as much as that of Pithecanthropus or of the Heidelberg man. The ridges over the eyes are also less pronounced. In general the facial features are more human than either of the earlier forms.

Herskovits[3] in describing this period says that the men who lived then had learned to fashion stones into tools which they used in killing game, for chopping, for skinning and scraping the skins of their game. Since the edges of the flints that they used for this purpose were chipped rough they could also be used for sawing. In fact, the use of this tool was something of a cross between the cut of a knife and a saw. The chips struck off in making these stone tools were very sharp and could also be used as a sort of rude knife. It is also probable that they constructed rude wooden tools. These, of course, have all long since perished. We do not know whether Piltdown man had a language, or whether he lived in communities or was largely solitary in his habits.

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[3] M. J. Herskovits, *Man and His World,* D. Van Nostrand Co., 1929, Vol. IV, "Making Mankind," pp. 110–111.

Lull gives the probable age of Piltdown man as 200,000 to 300,000 years ago.

Neanderthal Man.—Neanderthal man is the best known of our prehistoric relatives. The first specimen of this race was discovered in Gibraltar in 1848, but the better-known skeleton was found in the Neanderthal Gorge along a tributary to the Rhine River in Germany. A few other specimens of this race have been discovered. Neanderthal man was small in stature with a straight spinal column and curved legs. The head was set far forward on a heavy neck. The cranial capacity was even greater than that of modern man. He was half man and half ape in shape, but he had advanced far beyond the ape in many ways. We find associated with his remains shaped flints. The presence of ashes shows that he used fire. He also placed food and tools around his dead, indicating a belief in the hereafter. All these things are quite beyond even the highest modern apes. Lull[4] thinks there is possibly some relationship between Neanderthal man and certain retarded races still to be found in the Shetland Islands, Ireland, and Australia. Neanderthal man probably had his day during the Mouserian period and was later driven out and almost if not completely exterminated by his larger and more intelligent successor, Cro-Magnon man.

Neanderthal man shaped flints not only into a crude club but shaped them differently making sharp points for drills, sharp, rough edges for saws and sharp smooth edges for knives. He also used bone for making various kinds of tools.

Neanderthal man lived in caves as the climate was cold especially during the latter part of his period in Europe. It is from a study of the deposits left in these caves that we have been able to learn so much about him. It seems certain from the size of these deposits that he lived in social groups. Whether Neanderthal had a language we do not know. There are some fairly good reasons to suspect that he had some forms of communication much above that of the other animals of his time.

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[4] R. S. Lull, *et al.*, *The Evolution of Man*, Yale University Press, 1922, p. 28.

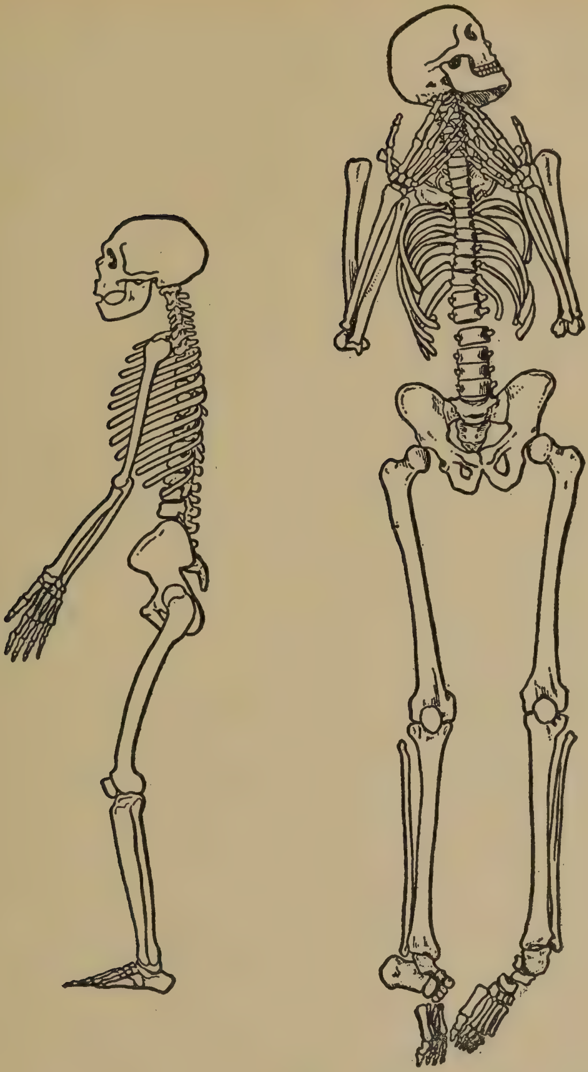

Figure 10. Skeleton of Neanderthal Man (left) Compared with that of Cro-Magnon Man. (From Lull, after Boule and Verneau)

Cro-Magnon Man.—Cro-Magnon man is described by Cole[5] as

> . . . straight of limb with an average height for the men of nearly six feet and the women considerably shorter. The head was long, narrow, and high, giving a cranial capacity slightly in excess of that of modern man. The forehead was full and smooth, there was a little forward projection of the upper jaw, and the chin was well developed. The cheek bones, however, were unusually wide, making the face appear disharmonic.

Cro-Magnon man shaped and polished his flints into useful tools. He sketched pictures of now extinct animals upon the walls of the caves in which he was compelled to hide. He even modeled small likenesses of these animals and himself. Cro-Magnon man was truly human. He is the first of the class to be called *homo sapiens* (wise man). But Cro-Magnon man is not our ancestor. He was driven out of Europe by invasions of a more intelligent race which probably came from somewhere in Asia.

Osborn thinks that Cro-Magnon man entered Europe from Asia by way of the Mediterranean sea about 25,000 to 30,000 years ago. One reason for this belief is the fact that there are more evidences of his presence in Europe to be found in Italy and other southern countries than in middle or northern Europe.

Cro-Magnon man is distinctly more human in appearance than any of his predecessors. His head is long and the face is narrow like that of the Latin races. The ridges over his eyebrows are smaller, the lower jaw is not so heavy but projects forward forming a chin giving a very modern appearance.

The implements of Cro-Magnon man are not greatly different from Neanderthal man. His method of burying the dead with implements and food placed near the body is also similar. In fact, it may be that Neanderthal man was not entirely extinct at the time of Cro-Magnon's appearance and that he borrowed much from the older race.

Osborn is very much impressed with the civilization of Cro-Magnon man. He says:[6]

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[5] Fay-Cooper Cole, in *The Nature of the World and of Man,* University of Chicago Press, 1927, pp. 362–363.

[6] H. F. Osborn, *Men of the Old Stone Age,* Charles Scribner's Sons, 1918, p. 272.

After prolonged study of the works of Cro-Magnon one cannot avoid the conclusion that their capacity was nearly if not quite as high as our own; that they were capable of advanced education; that they had a strongly developed aesthetic as well as religious sense; that their society was quite highly differentiated along the lines of talent for work of different kinds. One derives this impression especially from the conditions surrounding the development of their art.

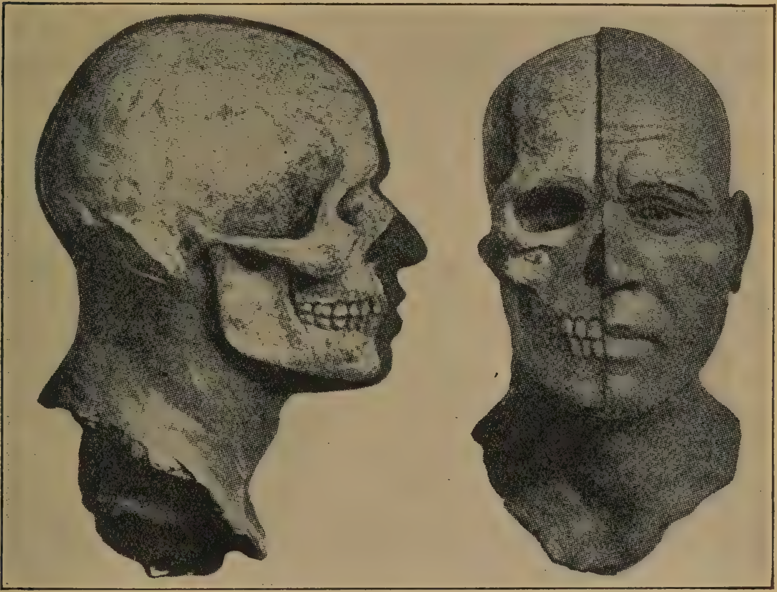


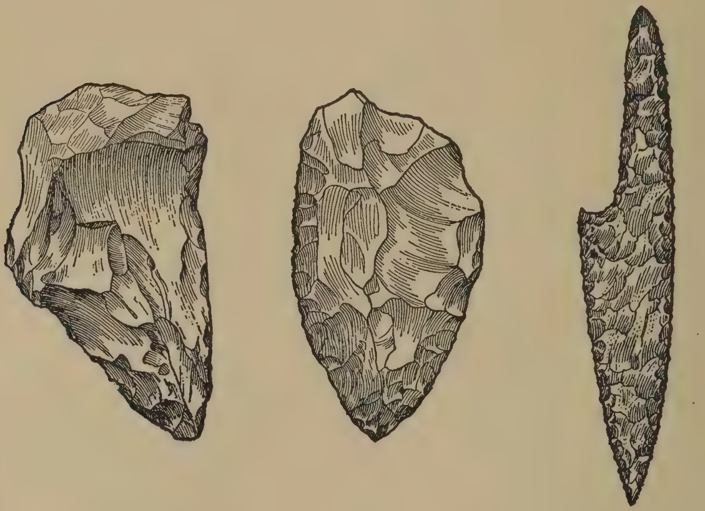
Figure 11. Head of the "Old Man of Cro-Magnon"

Rejuvenated by the restoration of the teeth, showing the method of restoration of the features adopted in all the models of J. H. McGregor. The diameter of the head across the cheekbones is seen to be greater than that across the cranium.

(H. F. Osborn, *Men of the Old Stone Age,* Charles Scribner's Sons, 1916)

Cro-Magnon man lived in caves and many illustrations of his art are still to be found on the walls of these caves. These consist of pictures of the animals, which he used for food and which some writers think he domesticated. These pictures are remarkably lifelike showing a keen sense of form and proportion. Beads were worn and some of these have been found buried with their dead. Small statuettes were also designed. Whether these were used in some form of worship is not known.

Included near some of the Cro-Magnon discoveries and buried in such a fashion as to show that there must have been some close connection between them, are some skeletons of another race which were decidedly negroid in form and features. This presents a very troublesome problem. We do not know whether there was an invasion of a race from Africa of which we have at present no other record, or whether this represents some chance mutation of the native stock.



A
Chellean Handaxe
(*Coup de Poing*)

B
Mousterian Point
Showing Chipping

C
Solutrean Point
Showing Lateral
Base Notch

Figure 12. Tools and Weapons Used by Later Prehistoric Races
(H. H. Newman, *The Nature of the World and of Man,* University of Chicago Press, 1926)

Later Prehistoric Races.—At this point in the story there is a great gap in our records. As suggested above, Cro-Magnon man was probably succeeded by races which emigrated from some birthplace in Asia. In the process of this development we must recognize that there was a differentiation into races. We shall not consider the problem of how many races there are, but rather accept the more common classification of three major races, white, yellow, and black. Did these races all originate from one common stock or were there several stocks developing simultaneously? We do not know. One guess is about as good as another. While climatic conditions account for most of the color differences, such an explanation does not account for other variations between the races, such as size, head shape, and facial differences. Even color presents some difficulties when we consider the dark skin of the Eskimo and the almost white Arab.

In their migrations the white races invaded Europe and conquered and destroyed Cro-Magnon man. But we have little record of these invaders. We should expect the number of remains to increase gradually from earliest man to the present. Instead of this, there are practically no skeletal evidences of the race which conquered Cro-Magnon man.

This gap is well filled by cultural remains. There is an almost complete continuous record of the development of better tools of defense and offense. From the earliest rough rocks which were used as hammers, we may trace our story through rocks at first rudely chipped and later carefully chipped and used as knife blades and spears. The idea of a barb on the spear added to its usefulness in hunting and fishing. Bone was also used. Needles were fashioned from the bone and eyes were drilled into them. This has been called the Azelian culture. It probably represents the work of the first Asiatic invaders.

The New Stone Age.—The Azelian culture was followed by what has been called the New Stone or Neolithic period. In this period the tools were principally made from flints, and were polished rather than chipped, a process which produced more useful and a better grade of weapons.

Although man had used fire for a long time for keeping himself warm and for roasting food, it was not until this period that he learned to produce fire from flints and sticks rubbed together. He also learned one new important use for it. By fashioning utensils out of clay and then placing them in the fire he was able to make pottery ware. In these vessels he could carry and cook his food better than before.

In this period the people often lived together in towns. Most of these towns were located along bodies of water, the seacoast, and inland lakes and rivers. Some of these have been submerged and others have been uplifted. These places have been called kitchen middens. Around these hearths have been found numerous weapons, the bones of animals used for food, and articles of pottery, some of which was delicately carved and painted. From a study of the remains of this civilization, MacCurdy believes that these people had domesticated animals, including the dog, horse, ox, sheep, goat, and pig. There is some evidence that they may have used some form of simple alphabet but the evidence is not conclusive. They used dugouts for boats and navigated the water near which they lived.

The dead were buried in graves formed by placing stones for walls and top. Some of these stones were huge boulders. We do not know how these early races were able to move these heavy rocks into place for their tombs. In the graves we also find pottery and weapons. This probably means that they believed in a future life and were deliberately preparing their dead for this life to come.

The Bronze Age.—It was probably by accident that man discovered the effect of heat on certain ores. Since copper was common and has a low melting point, it was one of the first which some of these early men found would melt when placed on their hearths. This molten copper they fashioned into utensils and ornaments. In some way they discovered that, when heated with tin ore, copper would produce a metal much harder than either tin or copper alone. Upon the basis of this discovery hangs the story of a new and greater civilization. This we call the bronze age. It dates from about 2500 B.C. to 900 B.C. In this period we find the beginnings of so many facts known to man that we speak of it as the beginning of the historical period. Since the purpose of this chapter was to trace the prehistoric evolution of man, the story naturally closes at this point.

In closing we should again raise the unanswered question of the origin of modern races. Without attempting to classify races did the modern white, red, and black races spring from a common source and gradually become differentiated because of climatic conditions? There is the further perplexing problem

Figure 13a. Puye Indian Ruins of New Mexico (A. R. Gilliland)

These ruins probably once housed several thousand people. Further ruins are to be found on the mesa directly above. These probably housed more thousands out of danger from the more warlike tribes of the plains below.

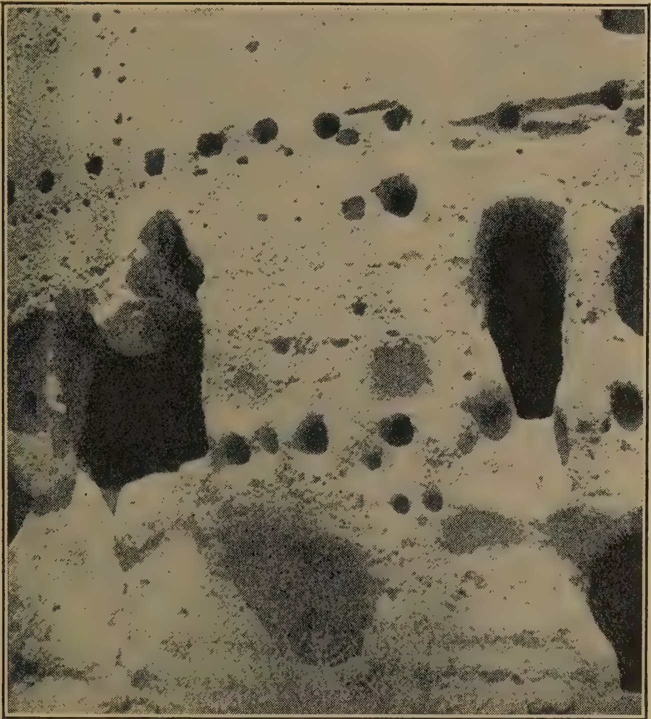


Figure 13b. A Close-Up View of the Same Ruins (W. R. Marshall)

The large openings were used for doors. The rooms were large enough for several people, often 8 by 10 by 6½ feet. The small holes in the walls were for poles which formed the floors and ceilings for another row of houses outside those which are remaining. The outer row of houses has long since been torn away.

of special interest to us as to the origin of the mound builders and the Indian. Although there are various theories concerning each of these problems they will not be presented in this brief sketch.

The remainder of the text will be devoted to the principles and problems of the development of the individual. This is called ontogenetic as distinguished from phylogenetic development. After considering the factors of inheritance, we shall study the prenatal and then the postnatal growth of the child.

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CHAPTER 6

THE FACTORS IN INHERITANCE

The Problems of Inheritance.—Thus far we have been concerned with the evolution of man from the earliest and simplest forms of animal life. This is only half, and the briefer half, of the story. Henceforth we shall be concerned primarily with the problem of the development of the individual from a single cell into an adult man. In this chapter we shall trace in some detail the potential characters bound up in the germ cell, how these characters are transmitted from the parents, and how the fertilized egg develops during its uterine period.

Characteristics of Cells.—Before entering into a discussion of these problems, it will probably be advisable to review some of the simple facts about cell structure and cell division. A typical cell consists of a small particle of protoplasm surrounded by a wall of thicker, denser material. The material within the cell wall is generally almost colorless and in most kinds of cells very viscous. It is called cytoplasm. Within the cytoplasm is a more solid material often darker in color, which is called the nucleus. This nucleus is also enclosed in a thin membrane. In most cells the nucleus contains a granular substance which is capable of being stained, and thereby is easily visible under the microscope. This substance is called chromatin. It must be understood that in the living cell the chromatin is not distinguishable from the other part of the nucleus. It is only after the death of the cell that the chromatin may be stained. Within the nucleus there is often to be found a smaller, still darker mass called the nucleolus.

Cells in higher plants and animals are of two kinds. There are body or somatic cells and reproductive or germ cells. The body of the organism is made up of somatic cells. These are further differentiated into muscle cells, bone cells, secreting cells, nerve cells, etc. In common adult plants and animals, at least at certain periods in their existence, another type of cell is produced. It has a special method of generation and a special function to perform. These are the germ cells. In general, there is much similarity in structure between body cells and germ cells except at particular stages in their evolution.

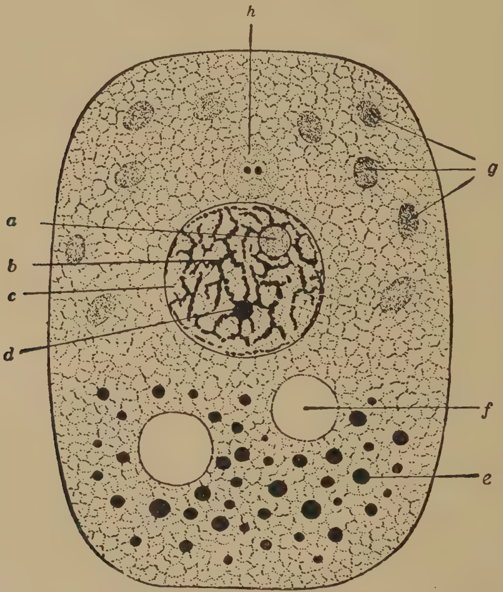

Figure 14. Diagram of a Cell. (From Wilson)

a-d, nucleus; *a*, nucleolus; *b*, chromatin "network"; *c*, linin meshwork; *d*, karyosome; or chromatin knot; *e*, metaplasmic inclusions in cytoplasmic meshwork; *f*, vacuole; *g*, plastids in cytoplasm; *h*, centrosome, recently divided.

Cell Division in Somatic (Body) and Germ Cells.—In human beings the process of cell division is rather complicated. The special method of division of germ cells will be described in more detail in a later part of this chapter. The part of the division which most concerns us at this point is common to both germ and body cells. This is the separation of parts which takes place in cell division. As the process of division or mitosis, as it is called, begins, there is a division of the centrosome, a small structure within the cytoplasm near the nucleus. As the

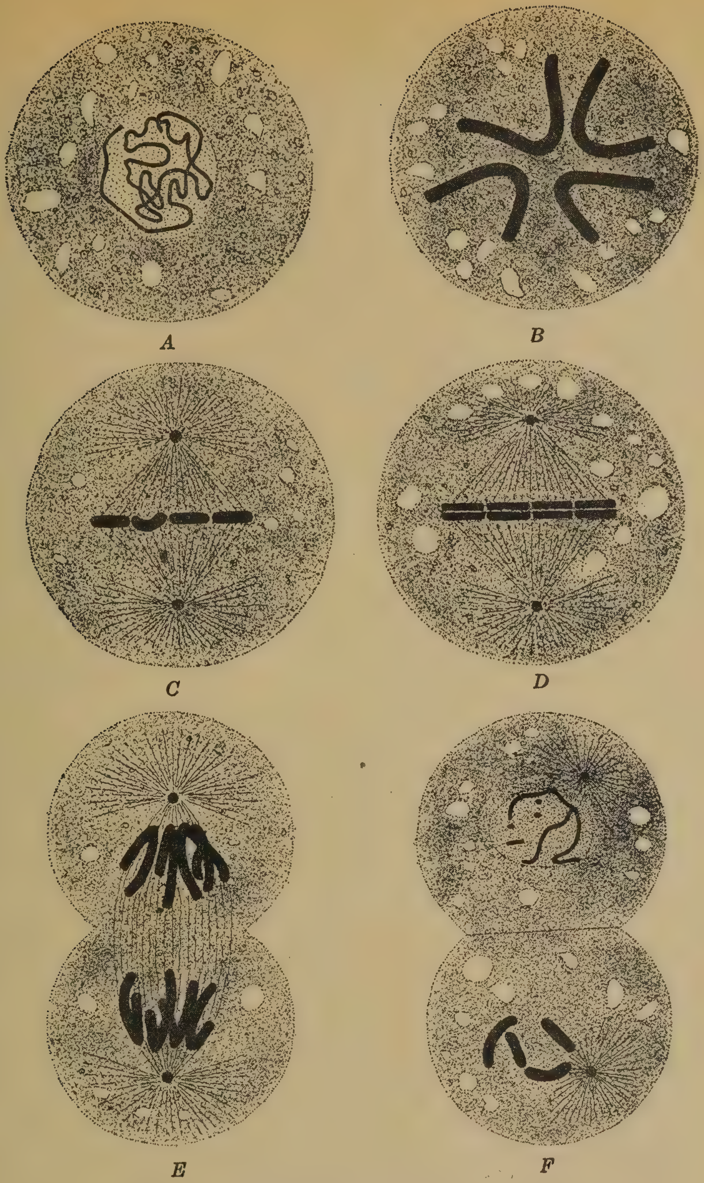

Figure 15. Division of the Egg of Ascaris

Drawing of actual specimens cut in thin sections. A, early stage, chromatin thread slightly condensed; B, chromatin thread broken into chromosomes which are arranged across the middle of the spindle; C, same as preceding, viewed from the side of the spindle, with chromosomes not completely in the section; D, chromosomes split lengthwise; E, chromosome halves moving apart, cell body beginning to divide; F, division of cell body complete, chromosomes in cell at top being reconstructed into a nucleus.

(A. F. Shull, *Heredity*, McGraw-Hill Book Co., 1926) centrosome divides, each part becomes the basis for a new cell. The chromatin also collects in strands within the nucleus and arranges itself in some definite fashion. As mitosis proceeds, the strands of chromatin break into fragments called chromosomes, and each later split longitudinally. Then the nuclear wall disappears and each half of a chromosome is pulled toward a centrosome, one half being pulled toward one centrosome and the other half toward the other. During the later stages of this process, the outer wall of the cell is reconstructed in such a way as to make each centrosome the center for a new cell. The chromosomes arrange themselves in order near the center of the new cell; a new nuclear wall forms around the chromosomes; the chromosomes dissolve into undifferentiated chromatin within the nucleus; first the nuclear wall and then the newly formed cell wall entirely separates; and two cells are produced. Each is very similar to the parent cell except for the fact that it is only about half as large. Growth takes place, and two adult cells result where only one formerly existed.

The chromosomes are the part of the germ cell which is especially important in reproduction. These chromosomes are the carriers of inheritance. It is they that determine whether the cell will develop into a fish, a man, or some other animal.[1] If the germ cell is that of a man, the chromosomes will determine his color, his physical form, and even his innate mental characteristics. We shall learn more about the structure and functions of chromosomes in a later part of this chapter.

Forms of Reproduction.—Like all the higher animals, man multiplies by means of sexual reproduction. There are different kinds of sexual reproduction, as well as some kinds that are not sexual. A brief summary of these different kinds of reproduction at this point may help us to understand the general problem better.

Fission consists in the division of the parent into parts, generally into two parts, called daughter cells. In this division the nucleus constricts and finally divides, each part collecting part of the cytoplasm and new nuclear material. If there is not a great differentiation of parts in this division, it is called simple fission. An example of this type of reproduction is to be found in the paramecium. If, on the other hand, there is a process of preparation in the parent cells, in which there is a collection of the chromatin of the nucleus into chromosomes with a longitudinal splitting of the chromsomes, one half going to each daughter cell, we call the process mitotic division or mitosis. Reproduction of cells in the human body is an example of mitotic division.

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[1] This statement is made largely for the sake of simplicity. The writer is in considerable sympathy with the point of view of Child, who claims that the environmental factors play a large rôle in the development of structure as well as function in all life. It is impossible to know what would happen if, for example, the fertilized ovum of a rat were permitted to gestate in the uterus of a dog.

Kinds of Reproduction

I. Asexual
  1. Fission
    (a) Simple
    (b) Mitotic
  2. Sporulation
  3. Budding
  4. Parthenogenesis

II. Sexual
  1. Conjugation
  2. True sexual reproduction
    (a) Hermaphroditic
    (b) Cross-fertilization

At certain times in the life history of the amoeba, as well as in many plants such as the mosses, we find a different method of reproduction. After a period of relative dormancy the amoeba breaks up into a number of small fragments called spores. These spores are, of course, very small as compared with the adult, but under favorable conditions each may grow to produce a new animal. This process is called sporulation.

In another type of asexual reproduction a small enlargement occurs upon the parent. This enlargement grows, takes shape, and finally separates from the parent. It develops into an adult similar to the parent. This type of reproduction is called budding. This is one of the methods of reproduction of the hydra.[2]

There is yet another method of reproduction, which some authors call sexual, but which we are here classifying as asexual. It is called parthenogenesis. In parthenogenesis specialized germ cells are produced. These germ cells develop and divide without fertilization. It is in this last respect only that parthenogenesis differs from ordinary sexual reproduction, but this is a real difference, especially in relation to the problem of inheritance. Certain crustaceans and the simpler arthropods reproduce by parthenogenesis.

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[2] A. F. Shull, *Heredity*, McGraw-Hill Book Co., 1926, p. 28.

Sexual Reproduction.—There are two types of sexual reproduction. The simpler type is found in one of the methods of reproduction of the paramecium. In this method two adult paramecia come into physical contact and exchange micronuclei (small nuclei). For this reason this process may be considered sexual. But there is an exchange of micronuclei only and not of true germ cells as we find in all other forms of sexual reproduction. This method is called conjugation.[3]

The steps in ordinary sexual reproduction are rather complex and differ somewhat for different species. The steps in the typical process will be described here.

In all the higher animals, as has already been mentioned, there are two types of cells, somatic cells and germ cells. Somatic cells are all the cells of the body not specifically concerned with reproduction of the species. The germ cells in structure do not differ essentially from somatic cells so far as external appearance is concerned, but they differ materially in their purpose and methods of reproduction. Somatic cells divide to produce the growth of the body and also to take the place of cells which are removed by accident or decay. The method is strictly mitotic.

The germ cells exist from an early stage in embryonic development, but they do not assume their peculiar characteristics until the period of adult life when reproduction becomes possible. The germ cells in the process of formation go through a rather complex process known as maturation. In preparation for later steps in the process, there are two regular mitotic divisions with a growth in the size of the cells.[4] In the process of these divisions there also occurs a peculiar kind of separation of the chromosomes into pairs. In fact, chromosomes regularly exist in pairs, one inherited from each parent. In ordinary mitosis the chromosomes split individually, lengthwise; but in this last

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[3] Shull, *op. cit.*, p. 22.

[4] See top of Figure 15.

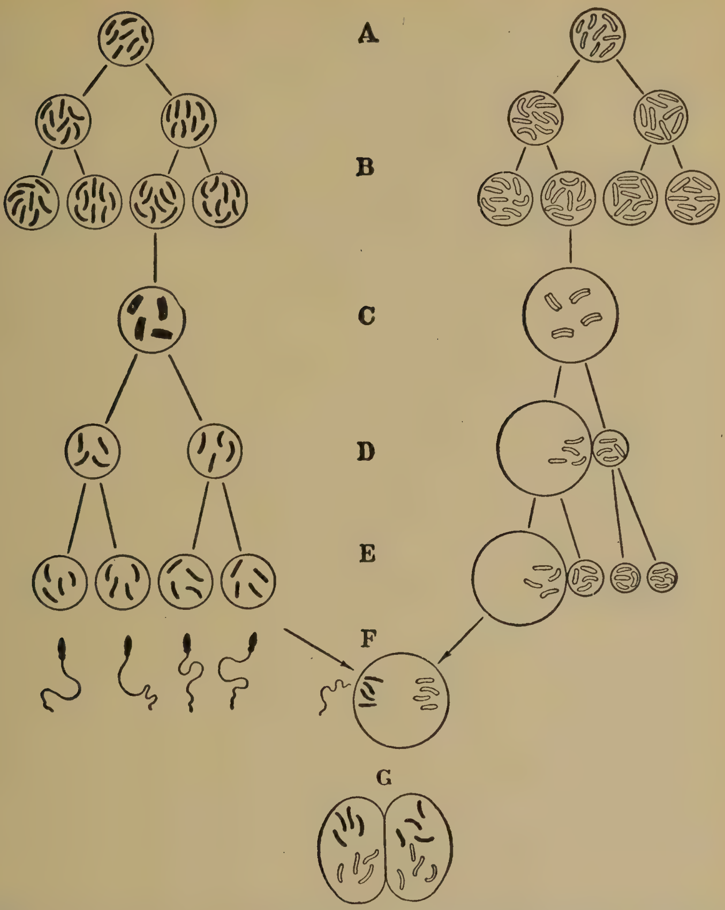

Figure 16. Diagram of the General Plan of Spermatogenesis and Oögenesis in Animals. (From Woodruff)

The somatic, or diploid, number of chromosomes (duplex group) is assumed to be eight. Male, to the left; female, to the right. A, primordial germ cells; B, spermatogonia and oögonia many of which arise during the period of multiplication; C, primary spermatocyte and oöcyte, after the growth period, with chromosomes in synapsis; D, secondary spermatocytes and oöcytes, with haploid number (simples group) of chromosomes, which have arisen by the first maturation (reduction) division; E, spermatids (which become transformed into sperm) and egg and three polar bodies which have arisen by the second maturation (equation) division; F, union of sperm and egg (fertilization) to form zygote with diploid number (duplex group) of chromosomes; G, chromosome complex of cells after first division of the zygote, and of all subsequent somatic cells, and germ cells until maturation.

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mitosis, these chromosomes, as already stated, arrange themselves in pairs.[5] In the next division, which is called a reduction division, the chromosomes do not split but the pairs split. In the resulting sex cell or gamete, there is just half the number of chromosomes that are regularly found in the body and germ cells.

All the chromosomes in either cell produced by the reduction division process come either from the paternal or from the maternal ancestors. In fact, in most cells there are chromosomes from each parent. Whether a particular chromosome comes from the mother or the father seems to be purely a matter of chance. Each normal cell generally receives chromosomes from each parent and each has one chromosome similar to the chromosome of the other cell.

Each of the cells which we have just been considering divides mitotically in the regular way twice more after the reduction division before the cells are ready for fertilization.

The only difference between the maturation process in the male and the female is that in the reduction division in the female one of the cells is much larger than the other. The small cell is non-functional and dies. Also in the next mitotic division, one cell is again larger and the other, a small one, is non-functional. The smaller cells are called polar bodies. In contrast with this, in the male all the germ cells, while they are much smaller than those of the female, are potentially functional.

In a large majority of cases the germ cells, both male and female, are excreted from the body and die. Only when the germ cells of the male and female unite under favorable circumstances for growth does fertilization take place. A new animal results from the union of the gametes or sex cells, as the final step in maturation is called, from the two parents. The two gametes, each carrying half the normal number of chromosomes, unite to form a single cell with the normal number of chromosomes. The first cell contains within it the potential elements of a new creature which is in some respects like one parent, in some respects like the other, and in some others like neither parent.

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[5] See C in Figure 15.

Inheritance Through Genes.—Let us consider briefly what is linked up in this infinitesimal unit of protoplasm. This cell contains the controlling factors in the heredity of the individual. Body structure as well as much of the mental structure is somehow carried in the fertilized germ cell. There seems to be rather conclusive evidence that these hereditary factors are carried in the chromosomes. Although spoken of as inheritance through chromosomes, the real basis of inheritance is more exactly spoken of as carried by means of genes. The gene is a small segment of a chromosome and is really the unit of inheritance. Each trait is inherited through a gene or a combination of genes. The genes are the real basis of unit traits. Like the chromosomes, the genes are in pairs; that is, there is one gene for hair color, for example, in one chromosome, and there is another gene for hair color in the homologous chromosome. Each chromosome contains many genes. For example, the drosophila (fruit fly) has four pairs of chromosomes, and more than four hundred characters have been isolated. Man has twenty-four pairs of chromosomes. The number of genes is not known, but it must run into the hundreds at least.

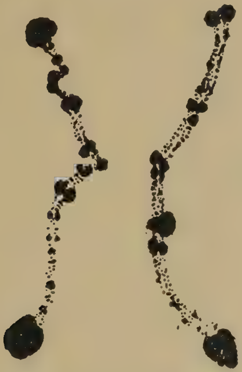

Figure 17. Chromosomes in Elongated Thread-like Form

Showing different kinds of elements arranged in linear order. These elements are called genes.

(A. F. Shull, *Heredity*, McGraw-Hill Book Co., 1926)

This, in brief, is the account of the beginning steps of reproduction. After the union of the male and female gametes, producing the first stage of the fertilized ovum, the problem becomes one of mitotic divisions, growth, and differentiation of structures. The first cell soon subdivides by mitosis into two, but the separation is not complete. These two cells in turn divide and redivide. The mass of cells first assumes a solid spherical form. Later the cells of the growing embryo congregate on the outside of a hollow sphere. At a still later stage there is a collapse of this sphere somewhat resembling a deflated rubber ball and the embryo is made up of two layers of cells. The cells begin to differentiate in form, and each kind assumes a different function. A third layer of cells forms between the other two, and further differentiation and specialization take place. We shall leave the problem of embryonic growth at this point and take up a study of the problems of inheritance of traits as such.

Mendelian Inheritance

The first systematic study of the problem of inheritance was undertaken by Gregor Mendel, a Czechoslovakian monk. His work was with garden peas. It was published in 1866, but attracted practically no attention until the article was rediscovered in 1900. His findings form the basis of what is known as Mendelian inheritance. While many have contributed to our present knowledge of the subject, the fundamental facts of inheritance were contained in Mendel's first papers.

There are innumerable problems concerned in any study of inheritance. These are to be found in inheritance in plants, but even more in animals. Any animal species presents almost unlimited problems in inheritance. Yet many of the principles are relatively simple. We shall start with one of the simplest possible cases. Instead of illustrating from human material, we shall select our examples mostly from plant life and from the lower animals, where the problem is simpler and more easily studied.

So long as we are dealing with pure traits the problems of inheritance are relatively simple. In such cases the offspring are like each parent since the parents themselves are the same. It is when we cross one trait with another that the problems arise.

When a tall variety of garden peas is crossed with a dwarf variety, what will be the height of the new variety? Will it be as tall as the tall parent? Will it be as short as the dwarf? Will it be somewhere between the two parents, and if so, will it be more like one or the other, or will it be midway between? Or will it bear any relation to either parent in height? Since height is only one factor in a plant or animal, any true and complete prediction will have to predict not only height but all the other factors of inheritance. A few of these are the size and shape of the leaf, the color of leaf and stock, the character of the flower, and the fruit, etc. In fact, one of our important problems is the determination of what constitutes the factors or unit characters as they are sometimes called. When these have been discovered, the problem then becomes one of discovering how they are inherited.

It will be clearer to discuss these problems in order. So long as single factors are dealt with, the problem is whether either parental gene has a controlling influence in the character of the offspring. If it does, we call this a case of a monohybrid with dominance. If each gene exercises an equal influence, it is called a case of monohybrid without dominance. If instead of studying one trait at a time, two or more traits are studied simultaneously, it is called a case of dihybrids or if three traits, trihybrids, etc.

Monohybrids without Dominance.—The simplest type of inheritance is that in which the parents differ in some particular and the offspring are all like each other but different from either parent.[6] An example of such a case is to be found in the snapdragon. When pure breeds of white and red snapdragons are crossed, all the first generation are pink. (The first filial generation is designated F_1.) When two of the pinks are crossed the results are not completely predictable. Some will be red, others white, and still others pink. If large numbers are used, it will be found that these colors distribute themselves closely to the ratio of one white, one red, and two pinks. A cross of a white with another white will give all white. These are called homozygous or pure. If the red is crossed with another red, the offspring will all be red. These are also pure. If a red is crossed with a white, the offspring will all be pink as in F_1. These are called heterozygous; that is, it is an impure strain. If a pink is crossed with another pink, the offspring will assume the proportions of one white, one red, and two pinks.

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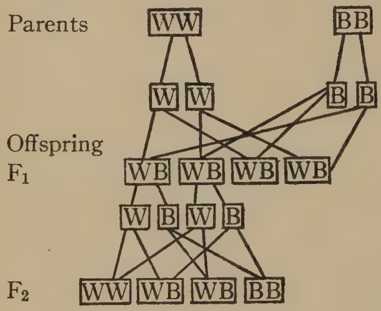
[6] It should be mentioned here that some geneticists do not speak of this as a case of lack of dominance but as a special form of partial dominance or failure of potency.

How may these facts be explained? The following diagram, illustrating the inheritance of color of fur in mice, will be of help. The principle is the same as that of inheritance of color of flowers in snapdragons. In this mating one homozygous parent is white and the other black. The heterozygous offspring are grey. Of course, there are two other offspring represented in F_1 which might pair with either of the two used in the illustration or with each other, but the resulting offspring



One pure white (WW), one pure black (BB).

Gametes in reduction division.

Possible combinations of gametes. Offspring all grey (WB).

Gametes in reduction division; all pairs will be the same.

Possible combinations of gametes. Offspring: one pure white (WW), two greys (WB), and one pure black (BB).

Figure 18. Simplified Schematic Representation of Reproduction in Monohybrids without Dominance

The above is a semi-schematic method of representing the facts of inheritance. The top row of symbols in the figure represents some trait in each of two parents. While these traits are always bound up with others in the chromosomes, for the sake of simplicity they are treated as though they functioned separately. In the parents each trait is represented by two letters. In germ cells the chromosomes and the genes in them are paired. The several regular mitotic divisions are omitted from this figure, and only the reduction division is shown, giving the unit factors represented singly in the gametes. These are shown in the second row from the top. These factors are crossed in all possible ways to give the first filial generation (F_1).

The first filial generation (F_1) is treated as parents for the second filial generation (F_2) and broken up into unit factors in the gametes as shown in line four. These are combined in all possible ways. Since all the F_1 are the same, only two of them are crossed. All other crossings would produce similar results.

would bear the same proportions as given above in F_2. The student is left to work out for himself the possibilities in F_3. It is to be remembered that (1) pure whites may be crossed with each other, (2) whites with greys, (3) whites with blacks, (4) greys with greys, (5) greys with blacks, and (6) blacks with blacks.

Monohybrids with Dominance.—Another type of inheritance is found, in which the offspring resemble one or the other parent in an inherited trait. There is no way to know beforehand which is the dominant character. By observation or experiment it will be found that certain traits are thus inherited. For example, Mendel found in crossing peas that tallness was dominant over dwarfness. That is, when a tall and a dwarf pea were crossed, the offspring of the first generation were all tall. But in the second filial generation not all were tall. The proportion of tall to dwarf was found to be about 3:1. This shows that, while all the F_1 were tall, they were not all pure in this respect. In the second generation, the proportion was one pure (homozygous) tall, two impure (heterozygous) talls, and one pure (homozygous) dwarf. In F_3 if a pure tall is crossed with another pure tall, the offspring will all be pure tall. If an

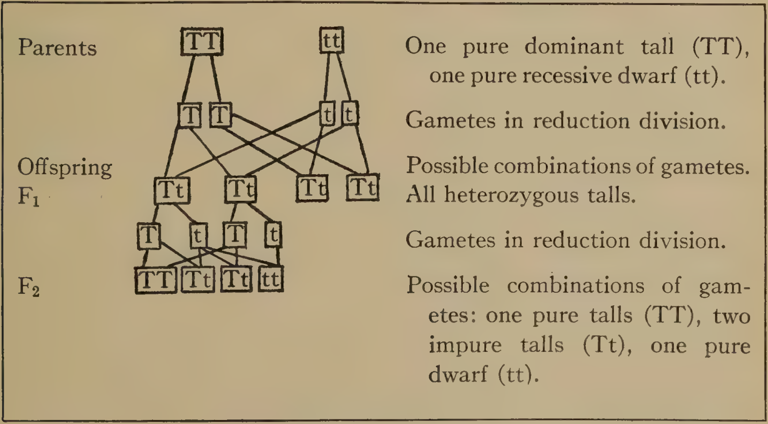

Parents
TT
tt
One pure dominant tall (TT), one pure recessive dwarf (tt).
T
T
t
t
Gametes in reduction division.
Offspring
F_1
Tt
Tt
Tt
Tt
Possible combinations of gametes. All heterozygous talls.
T
t
T
t
Gametes in reduction division.
F_2
TT
Tt
Tt
tt
Possible combinations of gametes: one pure talls (TT), two impure talls (Tt), one pure dwarf (tt).

Figure 19. Simplified Schematic Representation of Reproduction in Monohybrids with Dominance

Dominant traits are indicated by capital letters, recessive traits by small letters.

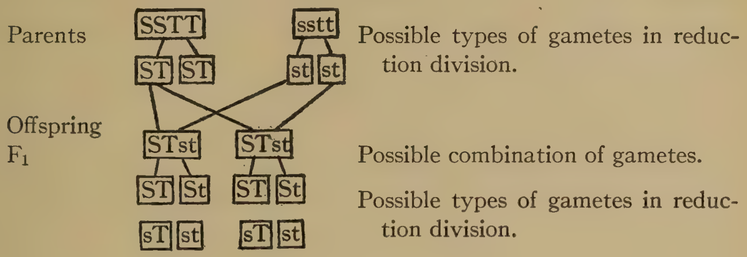
impure tall is mated with an impure tall, three out of four of the offspring will be tall; but only one out of three of these will be pure. If a pure tall is crossed with a dwarf, all the offspring will be impure talls. If an impure tall is crossed with a dwarf, half the offspring will be impure talls, and half will be dwarfs. If a dwarf is crossed with a dwarf, the offspring will all be dwarfs. This may be illustrated as shown in Figure 19.

Dihybrids with Dominance.—In their earlier work geneticists studied each strait separately, but later it was found that two or more traits could be studied simultaneously. This had a double advantage. It made possible much more rapid progress in research, since the problem of propagation always makes such studies time-consuming. If two traits could be studied at once, half or less than half as many generations would have to be studied. Furthermore, some characters have been found to be combined and mutually related. For example, color of hair and color of eyes are complexly related factors. Such a method permits the study of such complex factors.

Mendel in his study of peas studied not only tallness and dwarfness of the plant but smoothness and roughness of the seed. If a pure smooth tall pea is crossed with a pure rough dwarf pea, all the offspring will be smooth and tall. But if these smooth talls are crossed, four different results will occur. Some of the offspring will be smooth and tall, some smooth and dwarf, some rough and tall, and some rough and dwarf. The proportion will approximate nine smooth talls (only one of these will be pure), three smooth dwarfs, three rough talls, and one rough dwarf. This can best be shown by Figure 20.

The third generation would, of course, follow the same rules; but it would be much more complicated to work out all the possible combinations.

Only a few illustrations of each type mentioned here are given. Of course, there are many more, for all inheritance seems to be based on one or the other of these principles, or some variant of them. Hair color and eye color, as already mentioned, are further illustrations of inheritance. This list is sufficient to illustrate the principle. The geneticist already knows many such traits. However, much more painstaking experimentation will be necessary before it is possible to predict inheritance in many fields.


Parents
SSTT
sstt
ST
ST
st
st
Possible types of gametes in reduction division.
Offspring
F_1
STst
STst
Possible combination of gametes.
ST
St
ST
St
sT
st
sT
st
Possible types of gametes in reduction division.

F_2 Gametes of egg Gametes of sperm

	ST	St	sT	st
ST	SSTT	SSTt	SsTT	SsTt
St	SSTt	SStt	SsTt	Sstt
sT	SsTT	SstT	ssTT	sstT
st	SsTt	Sstt	ssTt	sstt

Offspring in F_2: 9 smooth tall, 3 smooth short, 3 rough tall, 1 rough short

Figure 20. Simplified Schematic Representation of Reproduction in Dihybrids with Dominance

S—smooth; s—rough; T—tall; t—dwarf.

This figure differs from the preceding in that the parent germ cells are represented as containing two factors instead of one. SS in the first parent represents one unit factor and TT another; "ss" represents one unit factor (recessive) in the other parent, while "tt" represents the other (recessive) unit factor. In the lower part of the figure the possible pairs of dual factors from each parent are crossed with each pair of the other parent. This rectangular figure presents a convenient way of illustrating all the ways in which these dual factors may combine.

Of course, as in the preceding cases, if one character combines with another, it really could not combine with any other. However, we are interested here rather in the possibilities of combination, and this is shown by the method used.

Three or more characters might be studied simultaneously. In such cases the problem would be especially complicated. Sometimes such methods are necessary. When the traits are related, as in color of wheat, where three factors are concerned, or the color of corn where four factors are concerned, the problem can only be solved by some such method as this.

Complicating Factors in Inheritance.—Difficult as such studies of inheritance are, there are still further complications to the problem. There are at least five or six further factors which must be considered in order to explain what we now know about inheritance. These may be considered further complications to the simple Mendelian laws of inheritance.

One of the last two cases mentioned, that is, inheritance of color in wheat, illustrates one of these complications. In the inheritance of color we find, for example, that in a certain kind of wheat two or more genes have a cumulative effect. These are independent but similar genes. When two color factors are present in this particular kind of wheat, the color is redder than when only one factor is present. Three factors in turn produce more color than two. Davenport believes that color of skin is inherited in some such manner as this. When the factors are similar and cumulative and carried in two or more pairs of genes, we call it a case of *multiple factors*.

When the trait is carried in two or more pairs of genes but the effect is not cumulative, it is called *duplicate factors*. An example of such inheritance is found in the shape of the seed capsule in shepherd's purse. There are two varieties of this plant. One variety has triangular shape as dominant. Two pairs of genes are involved. Whenever either of the two dominant factors is present, the capsule will be triangular. However, when no dominant factor is present, it will be spindle-shaped.

When a character is due to the combined action of two or more dissimilar pairs of genes, it is called an example of *compound factors*. The color of certain kinds of corn illustrates compound factors. Four pairs of dissimilar genes are concerned.

Many if not all these modifications are explained by Conklin as due to modifying genes. These modifying genes may be either (1) complementary, i.e., when added to a dissimilar factor makes it possible to appear (2) supplementary, i.e., when added to a dissimilar factor already effective makes it more or less effective, and (3) lethal which cause the early death of those animals in which they exist.

Some authors speak of another type of complication called *blending*. In such cases the offspring possesses a character somewhere between the characters of the parents. If long-eared rabbits are mated with short-eared rabbits, the offspring will have ears intermediate between the ears of the parents. There is considerable evidence that the inherited factors of intelligence are transmitted in this way. However, it seems to the writer that blending may be a name given to certain forms of inheritance which have not yet been successfully analyzed.

Linkage and Crossing Over.—The problem of inheritance is still more complicated. In many cases traits are linked or bound together in inheritance. When we come to consider the theoretical aspects of the problem, it seems reasonable that the genes in any single chromosome would be linked. For example, if color of hair, shape of hair, and color of eyes were all carried in one chromosome, they would, it seems, be inherited together. That is, if one of these were inherited from one parent, all the others would also be inherited from the same parent. Many such cases have been discovered. For example, in the common fruit fly, drosophila, there are four chromosomes, and four groups of linkages have been found, one for each chromosome.

The surprising fact of the matter is that not all traits in any chromosome are linked. We should expect that the factors in any single chromosome would be inherited together. When traits are located in different chromosomes we would not expect linkage. It seems reasonable to suppose that linkage, when it exists, would be complete, but this is not always true; that is, while certain traits are generally inherited together, almost always some traits are not so inherited. These exceptions present a serious theoretical problem which geneticists have explained by assuming that the chromosomes sometimes knot up and the parts cross over in the maturation process. If, for example, color of hair and color of eyes are usually linked, in some cases there might be a crossing over so that color of hair might come from one chromosome and color of eyes from another. The amount of total linkage or crossing over differs for different traits and may vary anywhere between 0 and 100%.

The fruit fly drosophila has been used in many studies of linkage. Two factors in this fly will illustrate linkage. Normal flies have red eyes and spines on the thorax. These are both dominant traits. The recessive homologous traits are pink eyes and spineless thoraxes. If a homozygous doubly dominant male is crossed with a homozygous doubly recessive female the offspring will all be heterozygous red spiney. If, however, a female of this family be crossed with a homozygous doubly recessive male, instead of getting equal proportions of the four possible combinations, the offspring will be about 4.5% red spiney, 45.5% red spineless, 45.5% pink spiney, and 4.5% pink spineless. This well illustrates the principle of linkage.

In this connection it should be pointed out that even dominance of which we have already spoken is not always complete. There are many cases of partial dominance. In such cases the usual proportions of the trait do not hold. Shull mentions cases of irregular dominance in which prediction is impossible.

There are also cases of delayed dominance such as in color of hair and eyes. In small children the hair is often very light and only gradually assumes the normal adult color. In such cases of course it is impossible to predict at first what the true color will be. The same general facts hold for color of eyes.

The familiar barred rock chickens are born black with a few white spots. At the first molt the black and gray bars appear. Walter[7] speaks of "reversed" dominance in which a trait which is dominant in one species may be recessive in another. Horns are dominant in sheep but are recessive in cattle.

Shull[8] also describes certain kinds of inheritance which he claims are not inherited through the chromosomes but through the cytoplasm of the germ cells. He cites the peculiar light green striping of corn as an example of such non-Mendelian inheritance. Such an interpretation has not been accepted by all geneticists.

Furthermore, many features of inheritance are greatly modified by environmental factors. The famous snowshoe rabbit changes color with changes in climate. Similar changes occur in the color of the fur of ground squirrels in different parts of the Pacific coast. In the higher altitudes the familiar red changes to a grey. The thickness and glossiness of the hair on such animals as the horse change in winter if the animals are allowed to stay out of doors.

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[7] H. E. Walter, *Genetics*, The Macmillan Co., 1924.
[8] Shull, *op. cit.*, Ch. XVI.

Inheritance of Sex.—Many studies have been made and many theories have been advanced for explaining sex. It has now been definitely determined that sex is inherited. It is inherited in the same way that other traits are inherited, that is, through chromosomes. In fact, the particular chromosomes that carry sex have been discovered. It is ordinarily called the X chromosome, or where two chromosomes are concerned they are called the X and Y chromosomes. The specific method of sex inheritance varies for different animals. In humans there are 24 pairs of chromosomes, that is, 23 pairs plus the sex chromosome. A female results when two X chromosomes are present, a male when an X and a Y are present.

This is shown schematically in the following diagram. It is apparent that the number of offspring will tend to be about

48		48		Parents
23 + X	23 + Y	23 + X	23 + Y	
23 + X 23 + Y	23 + X 23 + Y	23 + X 23 + X	23 + X 23 + X	Children
Males		Females		

Figure 21. Illustrating the Inheritance of Sex in Humans

equally divided in respect to sex. Sex is determined at conception, and which sex the child will be is a matter of chance. If the spermatozoon from the male which fertilizes the egg from the female is one that contains the X chromosome the offspring will be a female. If the spermatozoon contains a Y chromosome instead of an X chromosome, the offspring will be a male. These X and Y chromosomes carry more than primary sex characters. There are numerous sex characters such as body form, skin texture, as well as some less easily discoverable mental traits that are carried in the sex chromosomes. These are examples of sex influence or linkage.

Another trait which illustrates sex linkage is colorblindness. About 3% of men are colorblind to red and green. Very few women are colorblind. While limited almost exclusively to men, the character is transmitted through the female as well as through the male. It is only when the father is colorblind and the mother is colorblind or heterozygous to colorblindness that the daughter will show colorblindness.

Mental Inheritance.— The inheritance of mental traits presents many interesting but difficult problems. Such problems are especially difficult because of a lack of agreement on what constitutes these mental traits. There are two extreme views concerning the inheritance of intelligence. One group of writers believes intelligence is a unit trait and is inherited as such. The biologists as a group tend to hold this view and some psychologists also incline toward this doctrine. It is generally claimed that intelligence is a dominant trait and its opposite, feeblemindedness, is a recessive trait. Many studies have been made and family charts prepared to show that this is true.[9] There are others who hold that intelligence is due to environmental influences. Recently Watson has expressed the extreme view that given a healthy baby at birth he could make a musician, a lawyer, or anything else of him depending upon the type of training used.

The truth of the matter seems to lie somewhere between these two extremes. There are certainly some physical correlates of intelligence which are inherited. Quality and character of body cells and especially of nerve cells can hardly help but be factors. The number and interconnection of neurones are other factors. The physiological bases of tissue needs form the background upon which motivation depends. These are inherited factors. Yet the way in which these factors work out depends upon experience or training. A good heredity demands a normal environment for the full realization of its powers.

The studies of such histories as the Jukes family, the Kallikak family, and the Edwards family prove nothing for either side of the argument. Both inheritance and environment are inseparably bound together. It remains for a control of one against the other to present convincing argument of this question. Some evidence will be presented on this question in a later chapter of this text. (See Chapter 12.)

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[9] H. H. Goddard, *Feeblemindedness, Its Causes and Consequences,* The Macmillan Co., 1914.

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CHAPTER 7

PRENATAL DEVELOPMENT

The Basis of Inheritance.—This chapter deals very briefly with some of the important problems of human evolution before birth. As has already been indicated several times, the child is developed from the union of two germ cells. These are the ovum or egg from the mother and the sperm from the father. The ovum consists of a spherical mass about .2 mm. in diameter. The sperm is a many thousand times smaller, motile, elongated mass, which enters and unites with the ovum to form the cell which constitutes the beginning of life. While so much different in size and form, the ovum and sperm each have an opportunity to contribute an equal share when they unite in the formation of a new individual. The potentialities of development inherent in this union were sketched in the preceding chapter. In this chapter a brief account of the development of the child from conception till birth will be presented.

Periods in Prenatal Development.—This period can well be divided into three parts: (1) the period of the ovum, (2) the embryonic period, and (3) the fetal period.

The first period includes about the first three weeks after conception. Much of the character of this period can only be inferred from a study of some higher infra-human animals. No human embryo has been discovered less than ten days old and only rarely with less than three weeks' growth. Yet it seems likely that the human embryo goes through approximately the same stages as that of the guinea pig, rabbit, and other higher mammals. The first cell divides by mitosis, but there is not a complete separation of the cells. Each of these cells in turn subdivides and resubdivides making a 4-, 8-, 16-, 32-, 64-, etc. celled mass. At first these cells form themselves into a solid spherical shape. This is called the *morula* stage. Later the cells arrange themselves on the outside forming a hollow sphere, which is called the *blastula* stage. Then there is an infolding, and the ovum takes on the shape of a deflated rubber ball. In this stage, which is called the *gastrula* stage, the mass of cells has changed from a single to a two-layered stage. Between the outer cellular layer, called the ectoderm, and the inner layer, called the endoderm, a middle cellular layer begins to form. This is called the mesoderm. Each of these three layers is the forerunner of various later structures of the infant. Out of the ectoderm develop the epidermis of the skin, hair, nails, certain kinds of sense organs, nerves, and some of the glands. Out of the endoderm develop most of the linings of the internal organs of the body. Out of the mesoderm eventually develop the voluntary and involuntary muscles of the body, the skeleton, and the vascular system. But, of course, these last-named changes do not take place during the period of the ovum. During this period there is little or no differentiation of the layers into organs.

Starting about the last of the third week or the beginning of the fourth week, this differentiation begins. This is the embryonic period. During this period, although organ development is taking place rapidly, the form of the embryo bears little resemblance to the young child. Both the internal structure and the external appearance are far from that which they are finally to assume. Further description of the development which takes place in this period will be deferred to a later part of this chapter. The close relationship of human beings to other animals, and especially to the other mammals, is clearly shown during this period. This is illustrated in Figure 22.

Near the close of the second month the embryo begins to assume a more human form. While the outer form is not so different from that of other mammals, the typical human characteristics begin to assert themselves. To this third stage, which includes the last seven months of uterine existence, is given the name of fetal period. During this whole period, the appearance is distinctly human. Many of the organs, such as the heart, function regularly throughout the period. By the fourth month

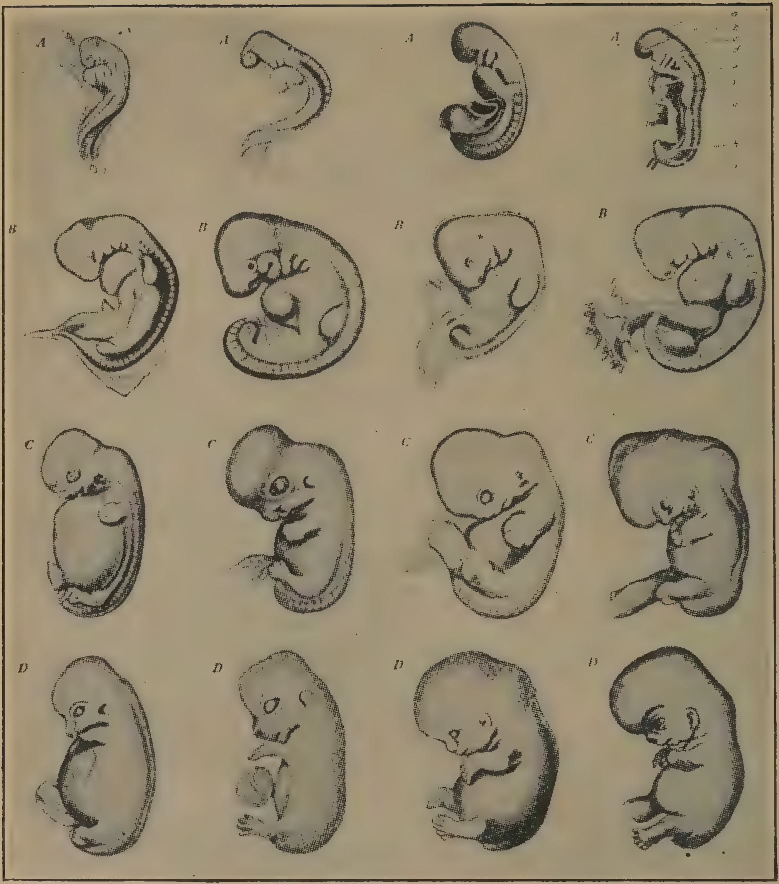

Figure 22. Embryos of the Pig, Rabbit, Monkey, and Man. (Slightly modified from K. Guenther, after Keibel)

Comparison at corresponding stages of development. The embryos of each animal are arranged in the vertical columns according to age, beginning with the youngest stage at the top. Stage A of the human embryo is fully labeled, and the corresponding structures in the other embryos can be noted. *a,* head region; *b,* eye; *c,* ear; *d,* gill slits; *e,* heart; *f,* fore limb; *g,* primitive muscle segments; *h,* hind limb; *i,* tail region.

(R. S. Lull *et al., Evolution of Man,* Yale University Press, 1922) movements begin, and the fetus prepares for its more vigorous life after birth.

Gross Development.—Very soon after fertilization the ovum inbeds itself in the walls of the uterus of the mother. There it becomes a parasite. As this parasite grows, some of the walls of the uterus are broken down, making room for its growth. The uterus itself also greatly enlarges. The fertilized ovum does not develop alone, but is surrounded by certain membranes and the placenta. The chief of these membranes, the chorion and the amnion, completely surround the growing ovum. In fact, it grows in the fluid-filled inner amniotic coat and is connected to the placenta by means of the umbilical cord. The placenta is supplied with blood vessels from the mother. Food is supplied to the placenta by the mother. Here it is absorbed by the blood vessels of the developing parasite through the umbilical cord. Only by osmosis does food pass from the mother to the fetus.[1] There is no direct connection between the two blood streams. In addition to food and waste materials which pass between the fetus and the mother, a few types of bacteria, protozoa, and some chemicals may make this circuit. Diphtheria, typhoid fever, influenza, and, probably, syphilis germs may pass from the mother to the fetus. Certain more or less destructive chemicals, such as ether, alcohol, arsenic, and quinine may also pass. Relatively few other substances seemingly do.

Let us now take up the evolution of certain major structures which originate within the second, or embryonic, period, briefly sketching their origin and growth. During the preceding period, as has already been stated, the ovum is first spherical and later flattens to a disc shape. (See Figure 24.) Gradually there is an enlargement, and during the third week there is an elongation of the mass. From this point onward specialization of the three layers of the ovum begins. While all three layers develop simultaneously, for the sake of simplicity and clearness each will be treated separately. Since the mesoderm becomes such a large part in terms of size, it will be described first.

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[1] Although three periods have been designated in intrauterine life, unless otherwise specifically stated, we shall hereafter, following common usage, use the words, ovum, embryo, and fetus rather loosely to denote only roughly the period under discussion.

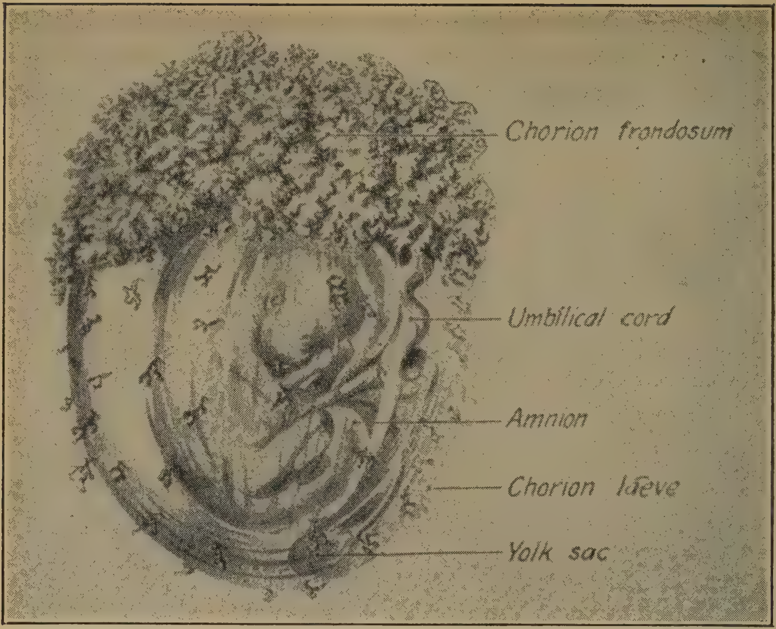

Figure 23. Fetus 4 Months Old within the Chorion and Amnion
(G. S. Dodds, *Essentials of Human Embryology*, John Wiley & Sons, 1929)

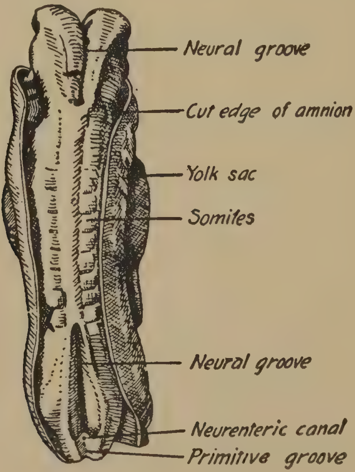

Figure 24. Dorsal View of Eternod's Embryo, 2.1 mm. Long. Age nearly 4 weeks. (From Kollmann's Handatlas)

However, before the internal structure is described, it may be well to describe the general changes in external appearance of the embryo and fetus. By the middle of the fourth week many external and internal structures have appeared. The three parts of the brain are to be seen. The heart has begun to appear, largely outside the main embryonic mass. The beginnings of the spinal column are clearly outlined, although there has yet been no clear differentiation of muscular and osseous tissue. The arms and legs have just begun to form as buds. These will grow somewhat as branches grow upon a tree. As elongation goes on, further specialization will produce fingers and toes. These are rather well formed by the eighth week.

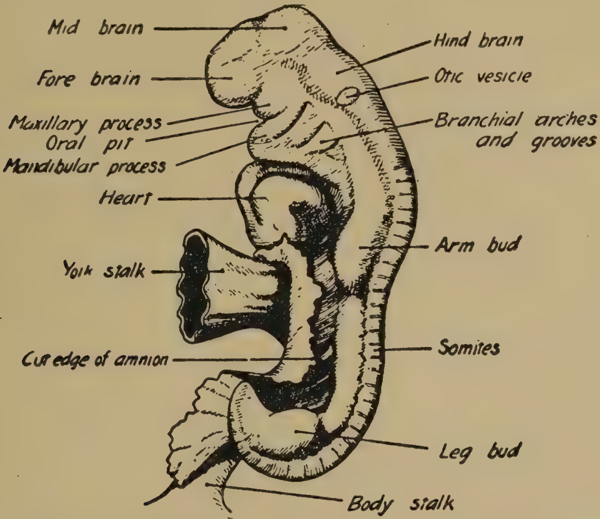

Figure 25. Human Embryo 4.2 mm. Long. Age about 4½ weeks. (After His)
(G. S. Dodds, *Essentials of Human Embryology*, John Wiley & Sons, 1929)

By this time the facial features have become more distinct by the formation of the mouth, the general contour of the nose, the eyes, and the ears. The grooves and four pouches in the head and neck region, which bear a close resemblance to the gills of fish but which never open, form the basis of parts of the ear, the upper, and lower jaws. At first these are cleft. Gradually they fuse in the mid line. Occasionally fusion is imperfect, producing hare lip, cleft palate, or other similar facial deformities.

From this time onward the growth is largely in elaboration and in size of the various structures already present. These will be traced from their various points of origin. The following paragraphs, therefore, will review in more detail the more minute and especially the internal structures and carry the descriptions through the entire prenatal period.

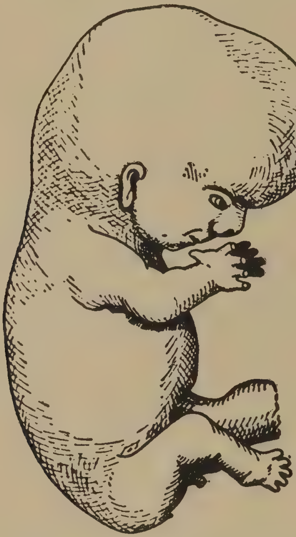

Figure 26. Human Fetus 23.5 mm. Long. (After His)

Age about 8 weeks. Shows definitely the assumption of the human form and marks the beginning of the fetal period.

(G. S. Dodds, *Essentials of Human Embryology*, John Wiley & Sons, 1929)

Developments from the Mesoderm.—The principal structures which evolve from the mesoderm are the bones, the muscles, the circulatory system, and the genito-urinary system. These structures arise from largely undifferentiated parts of this mesodermal layer of the ovum. The main part of the skeleton and muscular systems first shows as small ridges along the long axis of the embryo and forms the beginning of what later develops into the vertebral column. These ridges along the notochord increase in number until there are 41. They gradually differentiate into bone and muscle. The bones form the spinal col-

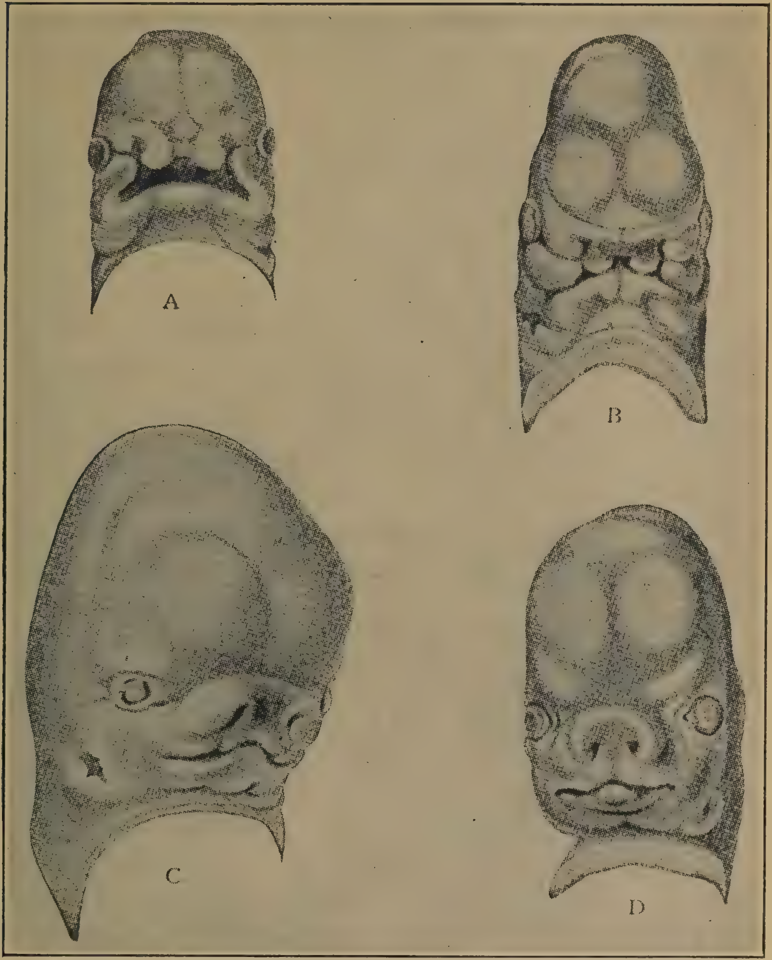

Figure 27. Development of the Face of a Human Embryo. (His)
(Prentiss and Arey, *Embryology*. By permission of W. B. Saunders Co.)

umn, the ribs, and part of the skull. Most of the other parts of the skull are formed from mesodermal plates which develop into cartilaginous bone as sheets over the brain. Cylindrical structures grow within the limbs as they grow. These structures develop into bone.

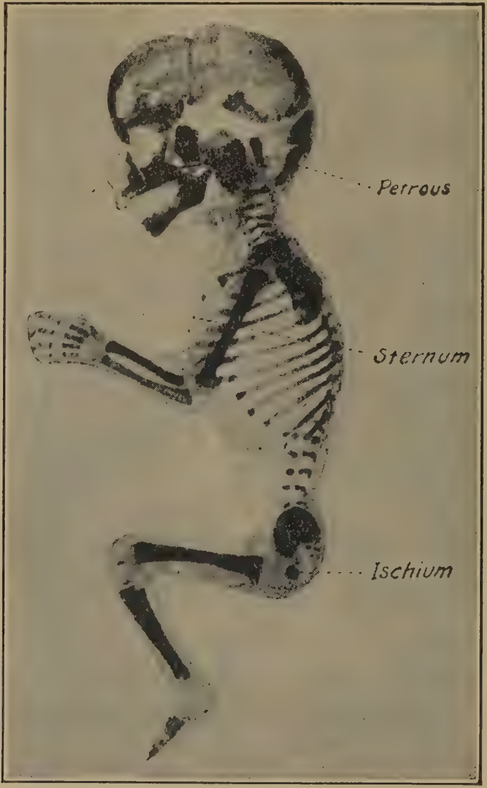

Figure 28. Retouched Photograph Showing Most of the Bones Present in a Fetus 140 mm. Long, Age about 17 Weeks, ×½
(G. S. Dodds, *Essentials of Human Embryology,* John Wiley & Sons, 1929)

At first there is no lime in the bones. But gradually from certain points ossification begins. Often several points of ossification begin in what later develops into one bone. For example, three different points of ossification arise almost simultaneously and continue until they unite to form the large thigh bone.

Ossification begins at about the ninth week and continues until well into adult life. However, most bones have begun to ossify by the thirteenth week and, as can be seen from the accompanying figure, are well under way by about the seventeenth week. The phalanges are among the slowest actually to become ossified, and several attempts have been made to measure physical maturity by X-rays of these bones.

Muscles are of three types: (1) voluntary, (2) involuntary, and (3) cardiac. The cells which develop into voluntary muscles elongate and usually arrange themselves along the bones. The nuclei of these cells seem to break up to form the peculiar striated appearance of such muscles. The muscle fibers generally arrange themselves in bundles which are bound together by connective tissue. As these muscle groups are attached to the bones and supplied with nerve connections, they are ready to assume their regular functions.

Most of the unstriped muscles develop from mesoderm in close relation to the entodermal layer and largely become fused with its development into the viscera. Other unstriped muscles are associated with the blood vessels. No special consideration will be given to cardiac development. It will arise only in relation to the problems of circulation.

The circulatory system is one of the first to develop in the embryo; in fact, it starts in the ovum period. Its special function is to carry food materials to the cells of the body and waste matter from the cells. At the beginning of the embryonic period certain blood vessels are present conducting blood between the placenta and the tissues of the embryo. This rudimentary system is evolved from the mesoderm. Among the first parts of the system to develop is the heart. It is derived from two slender tubes which fuse laterally. Later this single tube subdivides into two cavities, the auricle and the ventricle. This early development takes place in the neck region and partly outside the main body of the embryo. As growth proceeds, the heart migrates to its normal adult position. At another stage the ventricle is further subdivided, largely by folding, making three heart cavities much like that of the frog. Only just before birth are the auricles completely separated. Occasionally a baby is born without this last separation taking place. In such cases the blood is pumped from the heart without discrimination both to the lungs and to the arteries of the body. Since the blood that goes to the arteries has not been properly aërated, i.e., purified, by the lungs, it is partly venous blood and hence is bluish. A baby so born is called a "blue baby."

The arteries, veins, and capillaries in the embryo gradually enlarge and elaborate as growth proceeds. The one essential difference between embryonic and fetal circulation and circulation after birth is that in prenatal life the circulation is connected through the umbilical cord with the placenta of the mother. At birth this connection is severed, and the circulation takes place entirely within the body with the heart as the central organ.

Although entirely different in function, the kidneys and genital systems have a very similar origin and a very close physical relationship. They both develop from the mesoderm.

During the course of embryonic development three distinct types of kidneys are formed. The first, which probably functions for only a short time if at all, corresponds rather closely to the kidneys of the amphibians, such as the frog. The second kidney, which corresponds to that of fishes, functions for some time and then gives place to the true kidney. The canal from the two kidneys leads to the bladder and from there comes in close contact and really forms a common external orifice with the genital system.

The genital system is an early embryonic development. For the first six weeks there is no differentiation between the sexes. From this time onward, the sex of the embryo is certain. In one respect, at least, sex development is unique. Sexual growth really presents one unbroken continuum from generation to generation. Although rudimentary and non-functional before puberty, the early sex cells are the direct descendants of the parent cells and, therefore, represent the one permanent part of the race from one generation to another.

Developments from the Entoderm.—The chief developments from the entoderm are certain parts of the viscera, certain parts of the circulatory system just described, and many glands of the body.

The alimentary canal first develops as a tube during the third or fourth week. At first it is a closed tube with no external connections, and the tube is short and not greatly folded. As growth continues, the tube elongates, and many special structures grow out of it. The liver, salivary glands, the thyroid, the thymus, the lungs, and the pancreas are a few important organs which develop as elaborations of the embryonic gut. A description of all these elaborations of other parts of the canal is too detailed and technical for the purposes of this chapter.

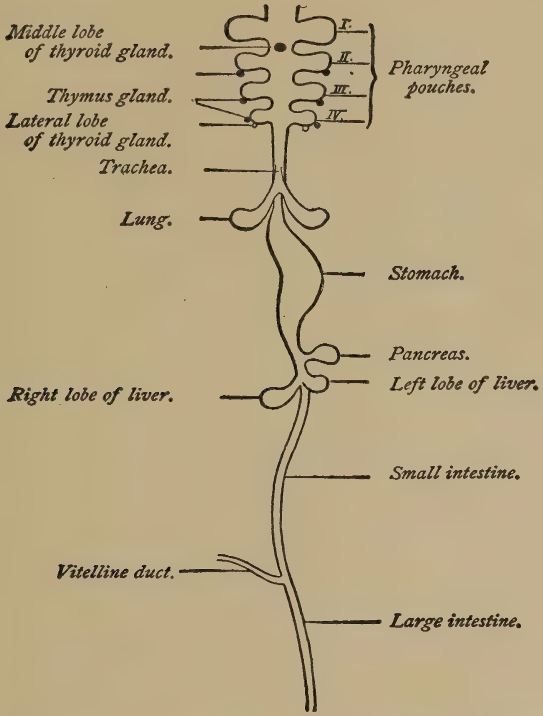

Figure 29. Organs Developing from the Rudimentary Alimentary Canal. (After Bonnet)
(Heisler, *Embryology*. By permission of W. B. Saunders Co.)

While the aesophagus or upper end of the alimentary canal is developing, the mouth is also forming, although separately. When well developed, only a thin wall separates these two structures. This ruptures about the fourth week, forming the upper opening of the canal. In a somewhat similar way the anal opening is formed. While the alimentary canal is thus well formed within the first few weeks, it has few functions to perform before birth.

It must be remembered that not all the alimentary canal is composed of entoderm. The muscular walls are derived from mesoderm. In a somewhat similar fashion we find parts of the entoderm becoming parts of the walls of the blood vessels. The various serous membranes which line the coelom and other internal cavities of the body are of entodermal origin.

The development of the pulmonary systems is so closely related in origin and function with the digestive system that a few words of description of it should be included here. The lungs originate as two pouches which develop along the sides of the aesophagus. These simple sacs enlarge and are filled with air tubes and blood vessels. Although there is rapid growth and elaboration, the lungs remain in a collapsed state until birth. At that time they greatly expand, and the air sacs fill with air. This is necessary, since from this point on the system must be supplied with oxygen and relieved of carbon dioxide through the lungs.

Developments from the Ectoderm.—The ectoderm develops into two important structures. The nervous system is derived by an enfolding process which will be described later. The epidermis is also formed from ectoderm.

At the beginning of the embryonic period the epidermis is composed of two layers. The outside layer is composed of flat smooth cells which are very translucent. This layer is shed about the sixth month. The skin at this time and for several months thereafter has much the appearance of the skin of fish. There develops on this skin a dense growth of fine hairs called *lanugo*. During later fetal life and early infancy this lanugo is largely replaced by true hair. However, on the face it remains to form a fine down. This condition remains throughout life in females. In males at puberty, probably due to certain secretions from the gonads, this fine growth of hair on the face is replaced by the beard.

The dermis or second layer of skin is a development of the mesoderm. This shows how intimately the early layers of the ovum may become fused in later development.

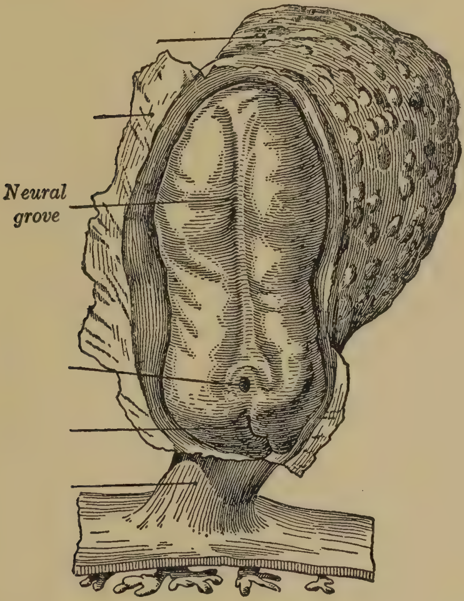

Figure 30. Human Embryo—Length 2 mm., Dorsal View.
(After Graf Spee)
(J. D. Lickley, *The Nervous System,* Longmans, Green & Co., 1912)

In the process of elongation, which occurs about the second week, there is a constriction along the long axis. As the constriction continues the outer layers enfold the constriction much as a tree heals over a wound in the cambium layer. In the enfolding process a portion of the ectoderm is entirely enclosed within the interior of the ovum. The enfolded material forms the basis of the nervous system. One end of this neural sac is enlarged and bent. This develops into the brain. Originally there are two constrictions in the enlarged end. Later two more constrictions form, dividing the brain into five parts. These original segmentations form the basis of the five parts of the adult brain, although during development there are changed rates of growth accompanied by shifts in the position of the different parts. Thus, for example, the cerebrum grows forward and

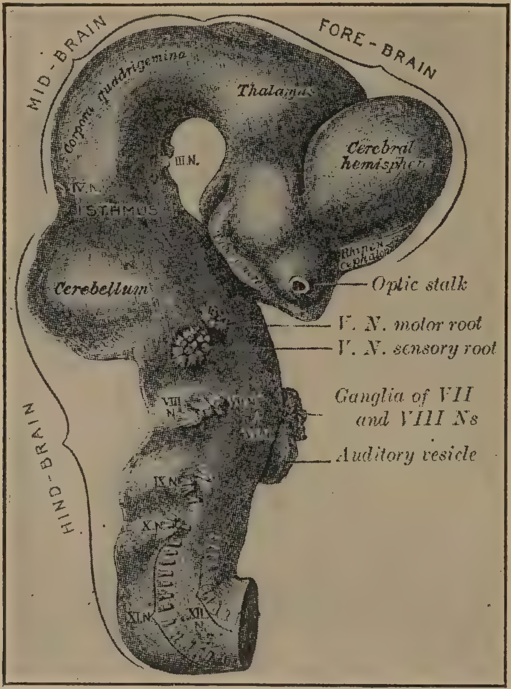

Figure 31. Exterior of Brain of Human Embryo of Four and a Half Weeks. (From model by His)
(J. D. Lickley, *The Nervous System,* Longmans, Green & Co., 1912)

then folds backward, covering most of the other parts of the brain. From the brain and other parts of the neural tube two sets of processes extend. One set eventually extends to the sense organs of the body and becomes the sensory nerves. The other eventually reaches the muscles and becomes the motor nerves. We do not know what guides these nerves so unerringly to their proper connections. Possibly it is due to some inborn chemical affinity. Whatever the cause, the growth is unerring. Although there are many individual variations, the arrangement of nerves always presents the same general pattern.

The sense organs have various origins. The cutaneous senses are elaborations of the skin. Smell and taste organs are elaborations of the nasal passageway and the tongue respectively.

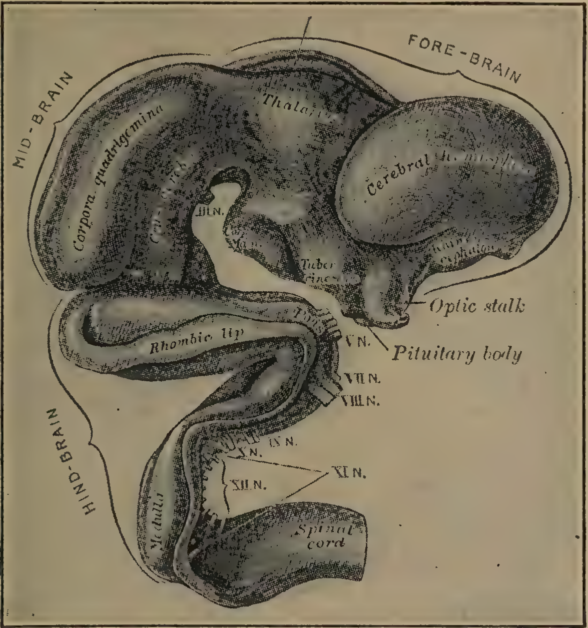

Figure 32. Exterior of Brain of Human Embryo of Five Weeks.
(From model by His)
(J. D. Lickley, *The Nervous System*, Longmans, Green & Co., 1912)

The ear is formed by the enfolding of the skin and certain growths from the mesoderm to form both the auditory and vestibular structures.

The eye has a peculiar evolution. The lens is formed from ectoderm. The retina is formed from the brain. A part of the brain actually grows outward from the brain region to the position of the eyes. Most of the remainder of the eye structure is a development of the mesoderm.

It is often difficult to trace the growth of any organ, due to the fact that it may migrate far from its point of origin. The shift of the heart has already been mentioned. The diaphragm originates in the throat region and later shifts to a position between the chest and thorax. The gonads develop near the kidneys and then migrate. In males they break through the abdominal walls, forming a part of the external sex organs. The path of this migration often causes a weakened condition which may rupture, allowing part of the intestines to pass through the opening. This condition is known as hernia. In females there is a migration of the gonads but they remain within the body cavity. Many other organs and especially some of the glands like the thymus and the pituitary also migrate.

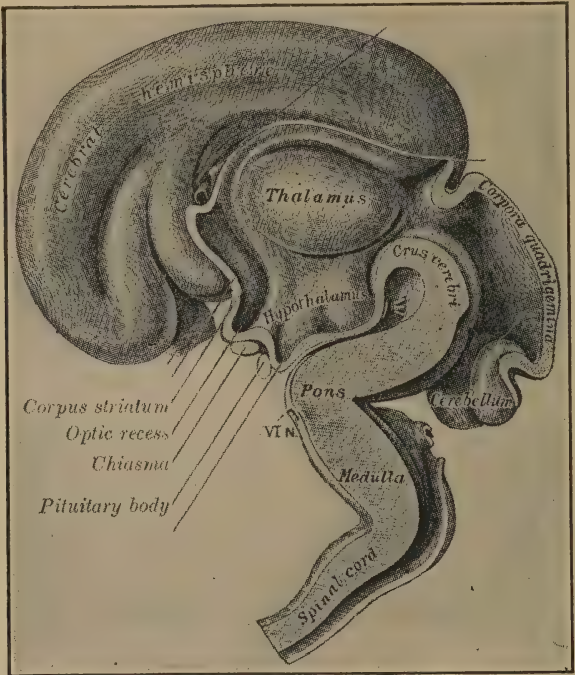

Figure 33. Median Section of Brain of Human Embryo of Three Months. (From model by His)
(J. D. Lickley, *The Nervous System,* Longmans, Green & Co., 1912)

In summary we may say that practically all the organs of the body are fairly well developed by the third month. By about the fourth or fifth month some activity begins. This activity increases until birth. Authorities differ as to whether any mental life occurs before birth. Although well-protected and carefully supported, some types of sensory stimuli, such as pressure, jars, and possibly dim light and sounds may reach the fetus. How much the unborn infant is modified by these is conjectural. It is certain that toxic conditions and general health conditions of the mother are greater factors than has been generally realized. We may find that emotional conditions have their origin in these early stages of development before birth.

In the next chapter we shall consider the important changes which occur at birth. We shall also consider the innate bases for later behavior, as well as the ways in which these native endowments are modified by experience. These modifications, which result from the very wide variety of situations in which the young child is placed, present one of the most interesting and one of the most difficult problems in psychology.

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CHAPTER 8

THE CHILD AT BIRTH

Changes at Birth.—Birth is a climactic event. After a certain period of fetal development, the mammalian mother, for some unknown reason, throws off the fetus. It then becomes a separate animal. The condition of the newborn animal varies greatly from one species to another. In some animals, for example, cattle and horses, the newborn offspring—calf or colt—is well developed and well able to take care of itself; in other species, such as the rat and man, the offspring is very helpless and requires much nursing and care.

The changes that occur in the human infant at birth are very great. From a condition of little excitation and sufficient food, the infant is suddenly thrown into a world full of all sorts of changes with which it must cope by no means the least of which is the securing of food. The many new adjustments which the human infant must make at birth may roughly be classified as physiological, sensory, and behavior changes.

Physiological Changes at Birth.—The essential vegetative apparatus of the child is developed before birth. All the principal organs of the body are formed, and most of them either have functioned or are ready to function at birth.

One of the chief changes at birth is in the manner of securing oxygen and the elimination of carbon dioxide and other waste products. Before birth oxygen from the mother passes through the walls of the placenta into the blood stream of the fetus. Likewise, carbon dioxide and other waste products pass from the fetus to the blood stream of the mother. At birth a sudden change occurs. The lungs, which have not previously functioned, expand and fill with air. If this does not occur in regular order at birth, a slap or other stimulation may be necessary to start respiration. When the air fills the air sacs of the lungs the blood has already reached the lungs. Oxygen then passes through the thin walls of the air sacs into the blood and is carried to all parts of the body. In return carbon dioxide is released from the blood into the air sacs and expelled by exhalation.

As described in the preceding chapter, certain circulatory changes occur at birth which are necessary for these respiratory processes. The auricle of the three-chambered heart is separated at birth by a wall into two parts. Thereafter the right auricle pumps blood to the lungs while the left auricle sends the blood, just aërated, to all parts of the body.

A further important change closely related to those already mentioned is that of temperature regulation. The fetus maintains a temperature slightly above that of the mother. The changes to which it is subjected are very slight and little regulation is necessary. At birth the child is suddenly subjected to an atmosphere which may often vary in temperature between 50° and 100° Fahrenheit. In order that the temperature of the infant may not vary, regardless of atmospheric changes, within limits not too wide, a proper balance of oxidation and perspiration must be maintained. So long as these processes are carried on properly all deeper structures and even those near the surface are kept at a temperature which seldom varies more than a small fraction of a degree. When the child or the adult is suddenly changed, as is often the case, from a bed with heavy covers to an ordinary room temperature, from one room to another, or from indoors to out-of-doors, the temperature may change as much as 20° to 100°. We can only marvel at the delicate adjustments which must take place in order that a chill or fever does not result. Our most delicate thermostatic heat controls for our homes do not approach such rapid adjustments.

Another important change is the method of obtaining food. Before birth the fetus obtains food by osmosis through the walls of the placenta from the blood stream of the mother to the blood stream of the fetus. These food products are obtained by the fetus in a predigested state.

The newborn child must obtain his food by sucking and swallowing. He must also digest this food. In this adaptation there are several new processes. Exploring for the food and sucking it into the mouth, whether it be from the breast or bottle, is a complex and difficult task. These acts are ordinarily considered to be reflexive and, no doubt, do contain a large element of the unlearned. Yet they are clumsy and ill-directed at first, and the rapid improvement shown is probably the result of practice.

There are other physiological adjustments, such as skin changes, change in the ratio of water to solid matter, and changes in myelination of certain nerve tracts. These are all less sudden and less evident than the other changes that have been mentioned. However, considerable importance has been attached by many writers to the myelination of nerve tracts. The myelin sheath is a grayish insulating covering of the nerve axones. The maturation of many reflexes and instincts has been explained on the basis of such myelination. It has been claimed that, at birth, the myelin sheath is absent or imperfectly developed in many nerve tracts. Shortly after birth, myelination has reached such a stage that reflexes and instincts begin to function with facility and accuracy.

Other writers have questioned this assumption. Some of these[1] believe that most of the improvement in function is due to experience. Sherman gives the per cent of coordination of eye movements for the first few hours after birth. He claims that this improvement is due to practice rather than to maturation. Thus the controversy goes. About the most convincing evidence on the question is the work of Breed and Shepard[2] on chicks. As will be remembered from the citation in a previous chapter, they studied the number of successful pecks made by young chicks in eating grains of food. One group of chicks was tested for their accuracy when they were two days old and for successive days thereafter. Other chicks were kept in the dark and fed artificially until they were four days old and thereafter were tested daily. Other groups were kept from pecking for longer periods. All the groups in the first practice period did about equally poorly, but the rate of improvement for the older chicks was greater. This experiment shows rather clearly that both practice and maturation are factors in improvement.

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[1] Mandel Sherman and Irene Case Sherman, *The Process of Human Behavior,* W. W. Norton & Co., 1929.

[2] F. S. Breed and J. F. Shepard, *Journal of Animal Behavior,* 1912, p. 278. (See graphs in J. B. Watson, *Behavior, An Introduction to Comparative Psychology,* Henry Holt & Co., 1914, p. 140.)

Sensory Changes.—At birth most of the sensory equipment of the child is present and ready to function. Before birth the fetus is subjected to some kinds of stimulation. Certainly tactual stimuli are present, and there is no reason to doubt that they produce responses. There is more question about the presence of the other types of sensory stimulation such as sound and light.

Unlike some of the lower animals the child is able to see at birth. The eyes are developed and the child is sensitive to visual stimulation. Often, however, the two eyes do not coordinate properly at first; but there is, nevertheless, an ability to see bright objects and to notice movements.

Preyer[3] in studying this problem distinguished four periods in the development of eye fixations. The first is staring at a bright object. This ability is present at birth. The second is turning the head from one bright object to another. This ability he says arises about the eleventh day. The third is following some bright object in motion within the field of vision. This ability appeared in his children at about the twenty-third day. The fourth is direct fixation upon objects within the field of view. This occurs about the tenth week.

While we certainly should not look upon these periods as clear-cut and distinct, they do show the successive steps in improvement from little or no ability in fixation and coordination to rather exact skill in eye control.

Other workers have found such ability present at earlier dates than was found by Preyer. Others have found it later. Kuhlmann places his test of following a lighted match moved before the eyes of the child at three months. This is probably a fair average for normal children.

Students working under the direction of Weiss and Rogers[4] at Ohio State University conducted a very carefully controlled study of several types of responses in infants during the first two weeks of life. In this study the infants were placed in an observation booth where the stimuli could be controlled and the reactions studied. These studies were both by observation and by means of a stabilimeter which gave graphic records of all movements. The observer by means of shorthand devices kept a very complete record of a large number of different kinds of responses.

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[3] Wm. Preyer, *The Mind of the Child,* D. Appleton & Co., 1888.

[4] A. C. Pratt, A. K. Nelson, K. H. Sun, supervised by A. P. Weiss and A. Rogers, *The Behavior of the Newborn Infant,* Ohio State University Press, 1930.

By means of this extensive technique they studied responses to both white and colored lights. Unfortunately the different primary colors were of unequal brightness value. While it is impossible adequately to summarize the results of this study in a few words, it may be said that at first there is little prediction as to the type of response that will be elicited by light stimulation. There is likely to be a response but it is often general and vague in character. As the child grows older there is a reduction of the general movements and a corresponding increase in eye movements. That is, the response to light becomes specific. White light gave more responses than the colored lights but this may be due to the fact that it was brighter.

Several authors believe the infant is capable of hearing certain sounds before birth. However, the ear of the infant is filled with amniotic fluid for the first day or more after birth. This certainly interferes with hearing, if it does not completely prevent it. When this fluid disappears, the normal child can hear. This is evidenced by the starting and crying as a response to loud sounds. It is probable that, like many of the other senses, hearing is very obtuse at first. The sound must be very loud or very near the baby before it is disturbing. It is not long, however, before the small child becomes very sensitive to the world of sounds around about him. They soon become important factors in life adjustments.

While there have been numerous experimental studies of the hearing of infants, most of such studies have not been carried on under carefully controlled conditions and the results are not very consistent. Preyer reports that infants twelve hours of age reacted to sound at the first trial. On the fourth day he reports that his son stopped crying upon hearing a whistle. On the eleventh and twelfth days his voice brought about similar results. Fright did not occur from loud noises until the twenty-fifth day.

Miss Shinn[5] found no sign of hearing in her niece until the third day. At that time she was startled by the sound of tearing paper. The age at which the head is oriented to sounds is variously given by different writers from thirteen to eighty days.

The opinions and evidence concerning the presence of the sense of taste at birth is conflicting. Some writers like Miss Shinn found no evidence of taste discrimination. Blanton found similar results. Preyer using weak solutions of sweet, sour, salt, and bitter found that the infants made wry faces at bitter and other responses to sour, salt, and sweet. In addition to the wry face they would shut their eyes and expel the substance from their mouth.

Canestrini[6] and Peterson and Rainey[7] conducted extensive investigations on taste in infants. The results of the latter study is summarized in the following table which gives data based upon 1,000 infants. There is a positive reaction toward sweet and a negative reaction toward bitter and sour. Salt does not give any very definite type of response.

TABLE 2. SENSORY REACTIONS OF 1,000 INFANTS

	STIMULUS			
	Sweet	Salt	Bitter	Sour
Response:				
Sucking	747	583	31	136
Rejection	37	395	780	695

Smell is even more difficult to study than taste, and the results are still more conflicting. Some writers believe the sense is functional at birth, while others are equally sure that it is not. Even the results of Weiss' pupils are inconclusive.

Watson studied the effect of removing support from the child. This caused jerking and crying responses, indicating that the sense of balance probably functions from birth.

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[5] M. Shinn, *The Biography of a Baby,* Houghton Mifflin Co., 1900.

[6] S. Canestrini, *Ueber das Sinnesleben des Neugeborenen* (monographien aus dem Gesamtgebiete der Neurologie and Psychiatrie, Berlin).

[7] Peterson and Rainey, "The Beginnings of Mind in the New Born," *Bulletin of the Lying-In Hospital,* New York.

Sherman studied the response to pain stimuli. From his results it seems evident that pain stimuli presented to the face or upper part of the body produce a definite crying response at any time after birth. On the other hand, if such stimuli are presented to the legs or lower part of the body, no such definite response occurs for the first few hours after birth.

Nursery experience with children from birth indicates that they are sensitive to warmth and cold in the form of room or bath temperatures. The child will cry at either extreme of temperature and will tend to be comforted by neutral temperatures. Neutral temperatures range from 33° to 48° C. Jensen found that infants are especially sensitive to temperature changes in food. Even a change of a degree or so profoundly affects their sucking movements.

There is not so much evidence concerning the other senses. We can only generalize by saying that most, if not all, of the senses are present but very obtuse for the first few days or even the first few months of the child's life. Some of the more important senses, such as sight, hearing, and taste, develop rapidly; while the others develop more slowly.

Behavior Responses of the Child at Birth.—The separation of sensory processes from reaction is largely, if not completely, artificial and unreal. There must be sensory stimulation of some sort before response takes place. It is also probably true that no sensory process is possible without a response. Sensory process and response, as the Gestalt psychologists have so strongly emphasized, are only two inseparable features of all simple reaction patterns. In complex patterns the connection between sensory process and response is more delayed and indirect but, nevertheless, present.

Human Reflexes.—It is in keeping with what has just been said to point out that several of the reflexes that are in the infant at birth have already been mentioned in this chapter, for example, the food-getting responses. The infant comes into the world with certain ready-made forms of response. Just how these are inherited we do not know. Somehow there is a lowered synaptic resistance or, in other words, a predisposition, without previous practice, to respond in a certain way when an appropriate stimulus is present. In many cases this is more of a tendency than a finished pattern. As already mentioned in this chapter, Sherman has shown (see Figure 34) that such a response as eye movements is very vacillating and imperfect at birth and improves rapidly with practice. Sherman also found that the Babinski reflex is greatly modified by practice; the typical extension of the big toe upon stroking the sole of the foot is soon changed to a flexion, the typical adult reaction. But he found that the one response changed to the other, depending upon circumstances.

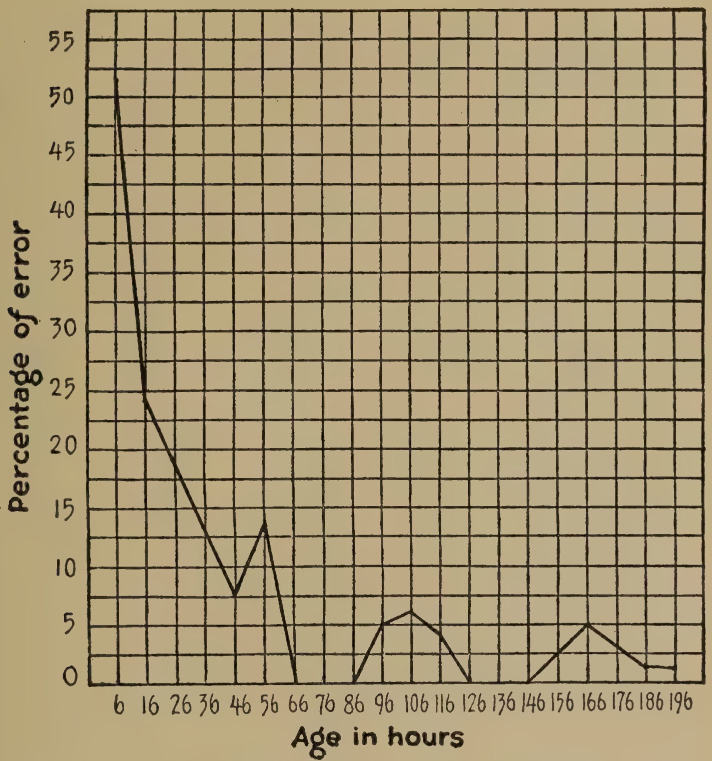

Figure 34. Coordination of the Eyeballs in Following a Light
(M. Sherman and I. C. Sherman, *The Process of Human Behavior,* W. W. Norton & Co., Inc., 1929)

As has already been pointed out, the purely vegetative responses are all ready to function at birth. These include such activities as circulation, respiration, and the various digestive processes—peristalsis, glandular activity, and expulsion of waste products. Sense organ adjustments such as eye movements are also present. Other responses include such activities as withdrawal from cold, heat, and pain; sneezing; hiccoughing; yawning; grasping; gurgling; and laughing (probably not present for the first day or more). Such forms of response are ordinarily called reflexes. The following table gives a more complete list of human reflexes.

1. Present at birth—little modified by training:

Reflexes involved in:

breathing
digestion
circulation
sleeping
sneezing
hiccoughing
attack
withdrawal
trembling
snoring

2. Present at birth—largely modified by training:

Reflexes involved in:

food-getting
crying
winking
accommodation
grasping
evacuation
micturition
fighting

3. Not observed at birth—appearing later in life:

Reflexes involved in:

body posture
holding head erect
sitting
standing
balancing
sex activity
vasomotor changes (blushing, etc.)
walking

Figure 35. Classified List of Some Human Reflexes
(A. R. Gilliland, J. J. B. Morgan, and S. N. Stevens, *General Psychology for Professional Students,* D. C. Heath & Co., 1930.)

The Instincts.—There is another type of response which is innate and present at birth but much less evident and specific until later in life. These are ordinarily called instincts. There has been a great deal of discussion in modern literature as to what kinds of behavior, if any, may be considered instinctive. Some authors, such as Kuo,[8] Ferris, Holt, and possibly Dunlap, have gone to the extreme of saying there are no such things as instincts. Gault[9] says there is one instinct—the tendency to activity, bodily and mental. Allport[10] and Watson in his earlier writings have named five or six instincts: (1) starting and withdrawing, (2) rejecting, (3) struggling, (4) hunger reactions, (5) sensitive zone reactions, and (6) sex reactions. McDougall[11] in his earlier writings listed twelve instincts, and in his later writings has added a thirteenth. Thorndike[12] names forty different instincts.

Manifestly these authors either mean very differently when they use the term instinct, or they differ greatly in their interpretation of reactions. Probably their differences are due to both causes. Must we, in defining the term instinct, limit it to those acts which are entirely innate and unlearned? If a writer maintains that the instinctive response must be perfect on first appearance and unvarying in later performances, there is no such thing as an instinct. If, on the other hand, we consider an instinct as a *tendency* to make a certain type of response in the presence of certain situations, then the list will vary in accordance with the amount of specificity of response demanded by the writer.

It is the belief of the present writer that Dashiell's[13] position is one of the most reasonable approaches to the problem. Dashiell discusses the fundamental tissue needs of the body. The body needs food. When the body has been deprived of food for a certain length of time, there is a tendency to seek food if food is not present, and a tendency to eat it if present or when found. This need of the body constitutes the drive which we may call an instinct. The form of expression of the tendency varies from one kind of animal to another, from one individual to another, and in the same individual from time to time depending upon the stimulus or his internal condition. Learning constitutes a large factor in the way in which the tendency is expressed. Learning determines to a large extent the kind of food we eat, as well as the way we procure the food and eat it after it is secured. The tendency is innate, while the way in which it is expressed is largely learned.

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[8] Z. V. Kuo, "Giving up Instincts in Psychology," *Journal of Philosophy,* (1921) Vol. XVIII, pp. 96–119.

[9] R. H. Gault, *Social Psychology,* Henry Holt & Co., 1923.

[10] F. H. Allport, *Social Psychology,* Houghton Mifflin Co., 1924.

[11] Wm. McDougall, *Outlines of Social Psychology* (13th ed.), Ch. X.

[12] E. L. Thorndike, *Educational Psychology,* Teachers College, Columbia University, 1914, Vol. I.

[13] J. F. Dashiell, *Fundamentals of Objective Psychology,* Houghton Mifflin Co., 1924.

Responses to temperature are included among tissue needs. If the temperature is either too cold or too warm, there is a tendency to withdraw from the source of the heat or cold. Of course, inactivity is not conducive to progress. Therefore, it probably is not accidental that the greatest activity of man is to be found in the temperate climates. Somehow the corresponding temperature below normal does not produce the same stimulating effect.

Sex is another type of drive. Certain glandular activity in the adolescent and adult produces a tension which, except for the food drive is probably the strongest drive in man. The effect of this drive may be manifested in many different ways. These may vary anywhere between general nervousness and bodily activity, and the most complicated activity of courtship and direct sexual activity.

In addition to the tendency to food-getting, there is also the tendency to the elimination of waste products. Evacuation and micturition may become just as strong an urge as any other.

Thirst represents another tissue need. Much the same things may be said of thirst as of hunger. It is interesting to note that nearly all these innate tendencies are susceptible to perversion. Strong stimulants and narcotics may be substituted for the natural satisfactions of hunger and thirst. Another closely related fact is that the perversions of these innate tendencies form the bases of the most serious types of crimes. Stealing, which is a form of perversion of the food-getting instinct, alcoholism, and sex misdemeanors constitute the bulk of the major causes of crime. These drives are strong forces in the normal lives of well-adjusted individuals and likewise they represent strong passions when they become abnormal.

The author believes that there are certain other tendencies which cannot well be classified as tissue needs, but which appear, nevertheless, to be innate. The tendency to seek and be with other people seems to be universal and unlearned. Trotter tries to connect this tendency to that of seeking bodily warmth. This is ingenious and interesting but not completely convincing. Others believe that gregariousness is entirely learned, but it is so universal that it seems more likely that it is an innate general tendency.

Fear is an innate tendency which seems to be an elaboration of the withdrawal response. Certain situations bring about this response, which is, in general, a method of protecting the organism from harmful consequences. The stimuli which produce fear and the responses it evokes may be widely varied, but there is an innate tendency to withdrawal.

Anger is somewhat similar to fear except that the response is expressed in attack. Certain situations provoke the attack attitude. Individuals differ in the strength of the tendency, and training greatly affects the form of its expression. In the inclusion of fear and anger as instincts we are referring to these as forms of gross response and not as emotions where they may also be included.

With the definition of instinct here proposed, play might also be considered as an innate tendency. It is almost universal when conditions of freedom and health are maintained. The form of expression varies greatly, but with our definition the form of expression is admittedly largely learned.

There are, no doubt, other innate tendencies, but there is no attempt here to give an exhaustive list of instincts. It is rather to describe what is meant by the term and to illustrate by typical examples.

The discussion of instincts thus far has been general and not specifically directed to the genetic aspects of the problem. Yet the important problems relating to the genetic aspects of instincts have been raised. If we assume that the nucleus of the instinct is a tendency to act in a certain general way when a particular situation arises, then that tendency can be assumed as being present at birth. In some cases, it probably is not present at birth, certainly not in its adult form, yet in a majority of cases it is. This part of the instinct is unlearned or innate. It is also usual for the tendency to express itself in certain forms rather than in others. In other words, the form of expression is not merely chance. The fact that most people react in a very similar manner when they are hungry, afraid, or angry is evidence of this. The similarity of such actions in infants and in different races is even stronger evidence that these reactions are not determined by chance alone. There is a certain direction in which the tendency manifests itself.

The same thing may be expressed in neurological terms by saying that certain sense organs when stimulated, especially when certain internal conditions exist, tend to produce responses in certain muscle patterns. Most of these tendencies exist at birth. Some of them, no doubt, become stronger some time after birth. Despite the contentions of the Freudians to the contrary, the sex instinct does not become especially strong until the period of adolescence.

The Instincts and Training.—Training has a great influence upon these instinctive tendencies. It is probable that the strength of the tendency is modified by training. Thorndike says there is no evidence that failure to function weakens the tendency, yet it seems likely that it does. Fear responses, for instance, seem to depend upon early fear experiences. However this may be, the greater influence of training is shown in the *form* of expression of the instinctive tendency. What the child learns to like as food, whether he eats at regular times or irregularly, whether he uses his hands or some piece of silver tableware to convey the food to his mouth—these things depend upon training.

The situations which originally excite the child to fear are few. Watson found only loud sounds and lack of support as causes of fear responses in infants. But the child soon learns to fear many other things. The hot radiator gives pain and may become a fear stimulus. The sudden sharp bark of a dog or the scratch of a playful kitten may produce a fear of the entire animal, and may even extend to a fear of all furry objects. Fear responses may vary as widely as the stimuli which produce them. The fact that fear is expressed in a certain way at one time in a particular situation is no guarantee that it will find the same expression at another time and in a different situation. It is quite likely, indeed, to express itself differently. The same thing may be said of the other instinctive tendencies.

Whenever the tendency and the pattern of response are not too greatly modified by training, we call the act instinctive. When the learning element predominates and the tendency is not in evidence, we call it a case of learning. As has already been pointed out, if the reader maintains that the form of the response must be completely innate, he will not find many instincts. He will have considerable difficulty in reconciling his differences with the one, who, on the other hand, is considering the *tendency* as innate. The latter will have a longer list of instincts, the number depending upon how finely he subdivides these tendencies.

Random Activity.—There is yet another type of activity of which some features are present at birth. In addition to the reflexes and instincts there are other types of response which cannot be classed as either. The child, when awake, is continually active. He moves his hands, his legs, his body; he moves his eyes, his mouth. He squints, he smiles, and does a hundred other things.

These activities, we think, are not spontaneous. There are some stimuli, internal, external, or both, which cause these movements; but the connection between stimulus and response is so loose and the response so unpredictable that we cannot class them as reflexes or instincts. The pathways in the nervous system are so nearly balanced that the responses from particular stimuli will vary from moment to moment. At one moment the response may be a kick, at the next a gurgle or a smile.

No doubt, if all the conditions were apparent, these movements could be fully explained as a response to a stimulus; since they cannot, we shall use the name random movements to describe them. A much more extended description of the value of these movements in the life economy of the child will appear in the next chapter. Suffice it to say here that random movements are the foundation upon which most of our skilled acts are laid. The child by random activity produces all the movements essential to skilled acts. These movements must be fitted together into appropriate patterns and must be associated with the correct cues. This is a problem of learning.

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CHAPTER 9

PHYSICAL GROWTH AND THE DEVELOPMENT OF SKILL

Weight and Height.—The largest relative gain in weight in the life of an individual occurs immediately after conception. When the first fertilized cell divides and each new cell grows to full size, it has practically doubled in weight. At the end of ten days the embryo has increased from about 1/100th of an inch in diameter to nearly five times this diameter and 125 times its mass. This growth continues throughout the period of gestation at a fairly constant rate until birth. At that time the average weight is 7½ pounds and the average length is 20 inches. Although there is considerable variation, Baldwin[1] found that 85% of the children he studied weighed between the limits of 6 and 9 pounds and varied between 17 and 22 inches in height. Harris[2] shows that, while these results are probably representative of the Teutonic races, there are rather significant racial or nationality differences in height and weight at birth, the Teutonic races being heavier and larger than most of the others. During the first year there is almost a trebling in weight and a gain of one-third in height. From this time on the gain is relatively less rapid.

The Growth Curve.—The form of the growth curve is a matter of much debate. Many studies have been reported giving measures of height and weight for the ages in which growth occurs. The form of the curves constructed from these data is not at all uniform. One of the most recent studies, reported by Scammon,[3] describes the growth curve as showing four rather definite phases. There is a period of rapid increase in infancy and early childhood; a middle period from about 3 to 12 years of age in which growth is slow; a period from 12 to 15 in which there is marked acceleration; and lastly a terminal period of slow increment.

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[1] B. T. Baldwin, "Physical Growth of School Children," *Iowa Studies in Child Welfare,* University of Iowa, Vol. I, No. 1.

[2] J. A. Harris *et al., The Measurement of Man,* University of Minnesota Press, 1930, p. 15.

[3] R. E. Scammon, in *The Measurement of Man,* p. 173ff.

TABLE 3. SHOWING WEIGHT AND HEIGHT OF CHILDREN FROM BIRTH TO MATURITY

(A summary of the records of Baldwin, Boas, Crum, Smedley, and others)

Age in Years	Weight in Pounds	Height in Inches	Age in Years	Weight in Pounds	Height in Inches
Birth—boys	7.5	20.3	13 yr. boys	85.8	59.0
girls	7.5	20.3	girls	88.0	60.0
1 yr. boys	20.8	28.6	14 yr. boys	95.3	61.5
girls	20.0	28.5	girls	99.0	62.0
2 yr. boys	26.0	32.5	15 yr. boys	104.5	64.0
girls	25.0	32.3	girls	103.8	62.3
3 yr. boys	31.0	35.0	16 yr. boys	112.2	65.5
girls	30.5	34.8	girls	110.0	63.2
4 yr. boys	35.0	38.8	17 yr. boys	121.0	67.2
girls	34.0	38.5	girls	114.0	63.5
5 yr. boys	39.6	41.6	18 yr. boys	127.6	68.0
girls	38.3	41.5	girls	116.6	64.0
6 yr. boys	46.2	43.6	19 yr. boys	131.5	68.5
girls	43.0	43.5	girls	119.0	64.5
7 yr. boys	51.7	45.6	20 yr. boys	137.0	69.0
girls	48.4	45.5	girls	120.0	65.0
8 yr. boys	57.1	48.4	21 yr. boys	139.5	69.0
girls	54.0	48.2	girls	120.8	65.0
9 yr. boys	60.7	50.8	22 yr. boys	142.5	
girls	59.0	50.6	girls	121.2	
10 yr. boys	66.4	53.2	23 yr. boys	145.0	
girls	64.2	53.0	girls	121.8	
11 yr. boys	71.5	55.6	24 yr. boys	146.5	
girls	70.4	55.2	girls	122.0	
12 yr. boys	77.0	58.0	25 yr. boys	148.0	
girls	77.9	57.6	girls	122.0	

The difficulty with all such measurements is that they are made on different individuals. If the same group of children could be measured yearly throughout the period of growth, we could get a certain answer to the problem of rate of growth. This would avoid the common error of taking the results from measurements of school children, with many more children in the younger ages and the gradual elimination of more of the smaller children in the upper grades. Due to selective factors, very few group school records are representative for the upper grades and the high school.

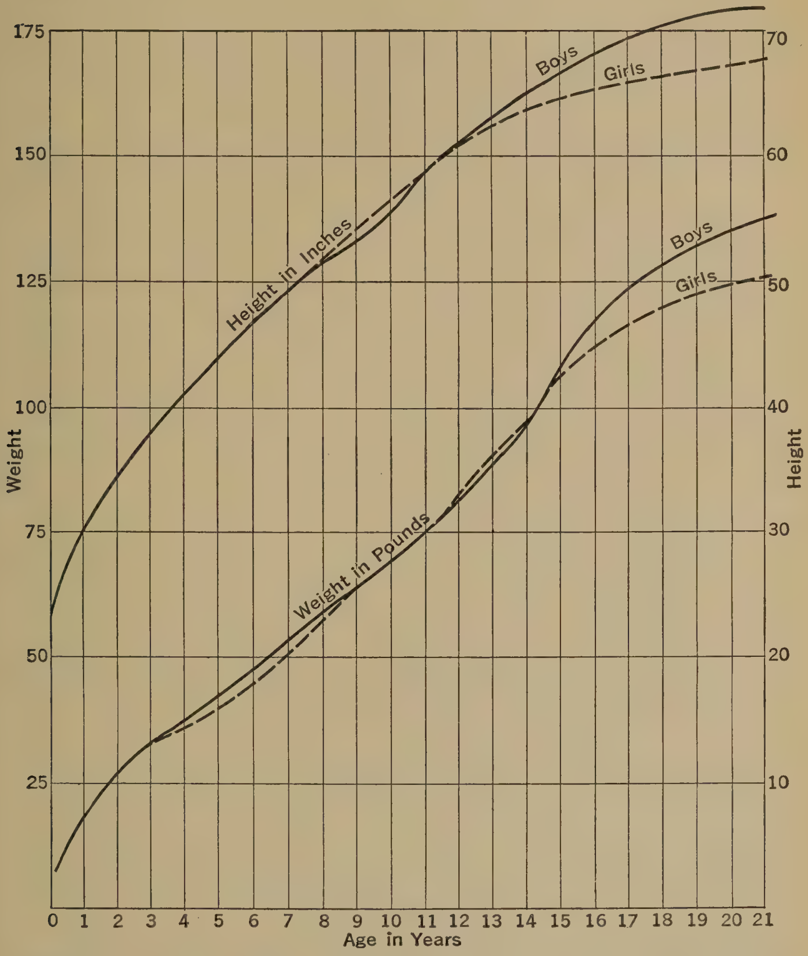

Figure 36. Age Changes in Height and Weight Computed from Table 3

In lieu of such data the writer has made a summary of as many sets of data as were found available. Only measurements of Teutonic races were included. The preceding results were obtained as averages for boys and girls for the different ages.[4] Although not agreeing with any single set of records, they are more representative than any one of the sources from which they were obtained.

Figure 36 shows some of the tendencies listed by Scammon, but the variations are not so pronounced as he found. In fact, both height and weight curves are almost straight lines, with slight positive acceleration at the beginning and more negative acceleration at the end. There is only a very slight acceleration in the curves at adolescence. This is probably due to the fact that the use of data from such varied sources has produced a better selection than from any single source. It is probable that most records have overemphasized the variation in average growth curves.

There is one respect in which averages cover up the real growth curves. Averages smooth out the irregularities which occur in the growth of any individual. Hence we do not have a true picture of the growth of a typical child.

Differences in Growth.—From our results it is apparent that, while boys are, on the average, larger than girls, this difference is very slight. In fact, it is so small that the difference is hardly apparent on the graph as drawn. The advantage of the boys is constant except for the pubertal period, during which the girls are slightly heavier and taller than the boys. Again, between 14 and 15 the boys overtake the girls and continue their advantage throughout the rest of life. In fact, the largest differences between boys and girls, or rather between men and women, is due to the fact that girls cease growing as rapidly as boys during later adolescence. Their curves of height and especially of weight become negatively accelerated at this period, while boys continue to grow at about the same rate as before for three or four more years.

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[4] These results were obtained from about fifteen major studies as reported in the following sources: Baldwin, *op. cit.;* F. Boas, "Growth of Children," *Science,* n.s., (1892) Vol. 20, pp. 251–252, and (1897) Vol. 5, pp. 570–573; F. Boas and C. Wissler, "Statistics of Growth," U. S. Bureau of Education, 1904, Vol. 1, pp. 25–132; F. S. Crum, Anthropometric Table, American Medical Association; F. W. Smedley, Report of Department of Child Study and Pedagogical Investigation, Chicago Public Schools, Chicago, 1900, Vol. 2, pp. 10–48.

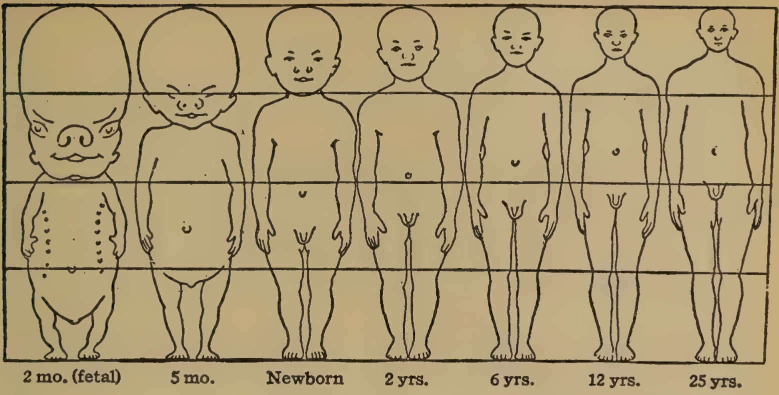
2 mo. (fetal)
5 mo.
Newborn
2 yrs.
6 yrs.
12 yrs.
25 yrs.

Figure 37. Changes in Proportion During Prenatal and Postnatal Growth. (After Stratz)

(From Morris's *Human Anatomy*, 9th ed. By permission of P. Blakiston's Son & Co.)

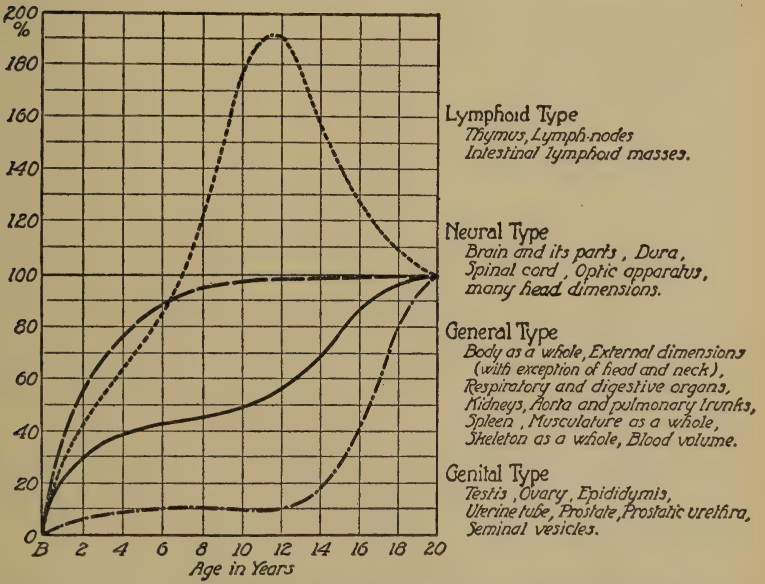

Figure 38. A Graph Showing the Major Types of Postnatal Growth of the Various Parts and Organs of the Body

The several curves are drawn to a common scale by computing their values at successive ages in terms of their total postnatal increments (to twenty years).

(J. A. Harris *et al.*, *The Measurement of Man*, University of Minnesota Press, 1930)

A great deal of discussion has been raised by G. Stanley Hall and his students concerning the adolescent spurt in growth. Even such a recent writer as Mrs. Hollingworth[5] says that some adolescents grow as much as 6 inches and gain 20 or 30 pounds in the first year of puberty. While such changes may occur in exceptional cases, they are evidently little greater than at other periods or they would show in the averages for ages 12 to 14 in our data. This topic will receive further consideration in the chapter on adolescence.

In addition to the growth of the whole body, we are here interested in the growth of the various parts and their relation to each other. The relative growth of the different parts of the body is shown in Figure 37 on page 151.[6] From this drawing it is apparent that the head is almost as long as the rest of the body at two months of embryonic development. At birth the head is one-fourth the total length of the body. After birth the head grows slowly. At 4 years of age the head has almost reached full size. Due to the growth of the other parts of the body, the relative size of the head continues to decrease in proportion to the rest of the body. On the other hand, the legs grow in length and at maturity they are almost half the length of the whole body.

In contrast with these changes Scammon has found that many parts of the fetus grow at very regular and uniform rates. It is after birth that the great differentiation in some of these parts occurs. These differences Scammon classifies under four types. They are (1) lymphoid types, (2) neural types, (3) general bodily types, and (4) genital types. The relative differences in rate of growth of these different body types are shown in Figure 38.

From this chart we see that certain lymphoid parts of the body, such as the thymus gland, the lymph nodes, and the lacteal tissues, grow very rapidly in the early years, reach their maximal growth by the twelfth year, and then deteriorate or at least do not keep up their rate in comparison with the other parts of the body. The neural type maintains a regular negatively accelerated growth almost reaching the maximum by school age. The general bodily growth curve has two accelerations, one in the preschool period and one during puberty. The genital types lie dormant till puberty and then accelerate rapidly.

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[5] Leta S. Hollingworth, *The Psychology of the Adolescent,* D. Appleton & Co., 1928.
[6] Henry Morris, *Human Anatomy,* W. B. Saunders Co.

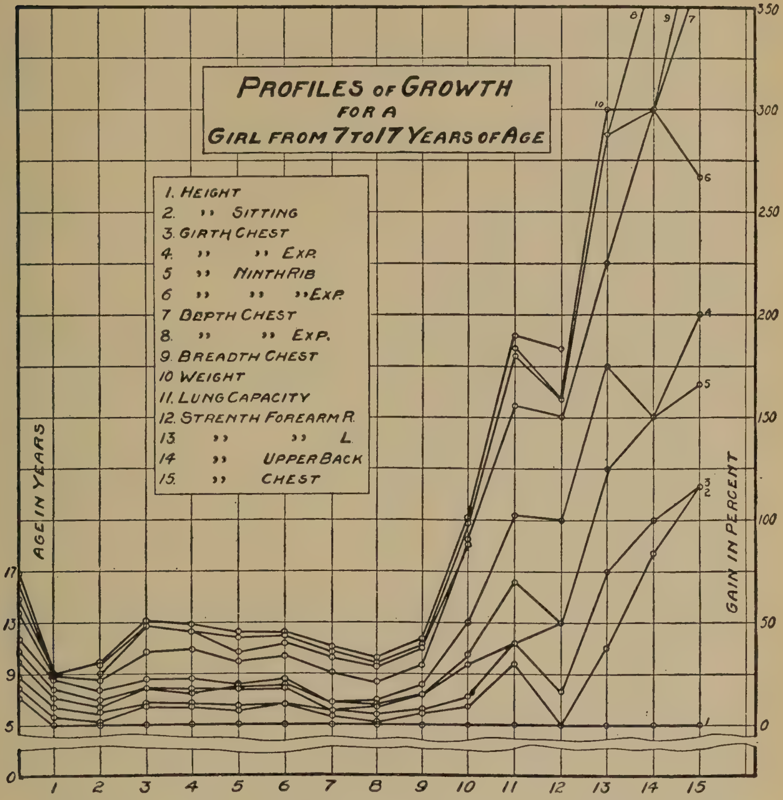

Figure 39. Profiles of Growth of a Girl from 7 to 17 Years of Age
(B. T. Baldwin, *University of Iowa Studies in Child Welfare*, Vol. I, 1921)

Baldwin[7] has made a study of the growth of different parts of the body of the same children from infancy to adolescence. The results presented here give yearly growth for fifteen different measurements of parts of the body for a girl from the age of 7 to the age of 17. These results are typical.

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[7] Baldwin, *op. cit.*, p. 114.

The ductless glands, which play so large a part in body growth, also show great changes in rate of growth. Figure 40 shows these differences. These growth curves lend credence to the belief that body changes, as well as body functions, depend in a large degree upon the balance in endocrine gland activity.

The skeleton undergoes many changes during growth. These are not only the changes in length and size, which largely account for body size, but also the changes in chemical composition. At birth the bones are little more than cartilage or membrane. Calcium, phosphorus, and other mineral salts are introduced rapidly into the bone structure. As a result, at the end of the growth period and even before that, the bones have become hard and rigid. There has been a gain of 60% to 68% of mineral matter in the bones.

The muscles also undergo great changes during childhood. The total mass of muscle tissue increases from 23% of the body weight in the child to 43% in the adult. During this time the composition of the muscles changes from 72% of water and 28% of solid matter to 66% of water and 34% of solid matter. This is just another way of saying that the muscles become firmer and stronger.

More difference occurs in the proportion of muscle and body fat and in the structure of muscle tissue between boys and girls than in almost any other physical or mental trait. At birth there is little difference between the sexes. At adolescence the boy is a half stronger than the girl, and at maturity the man is twice as strong as the woman.

Many changes occur in the internal organs of the body during the growth period. The organs of digestion, circulation, and respiration are relatively about twice as large in the newborn infant as in the adult. On the other hand, the brain is relatively eight times as large. These and other less apparent changes characterize the processes of growth in man. We shall now turn from the more purely structural changes to the problem of changes in function. Special emphasis will be placed on the function of the muscles and nervous tissue in the development of skill.

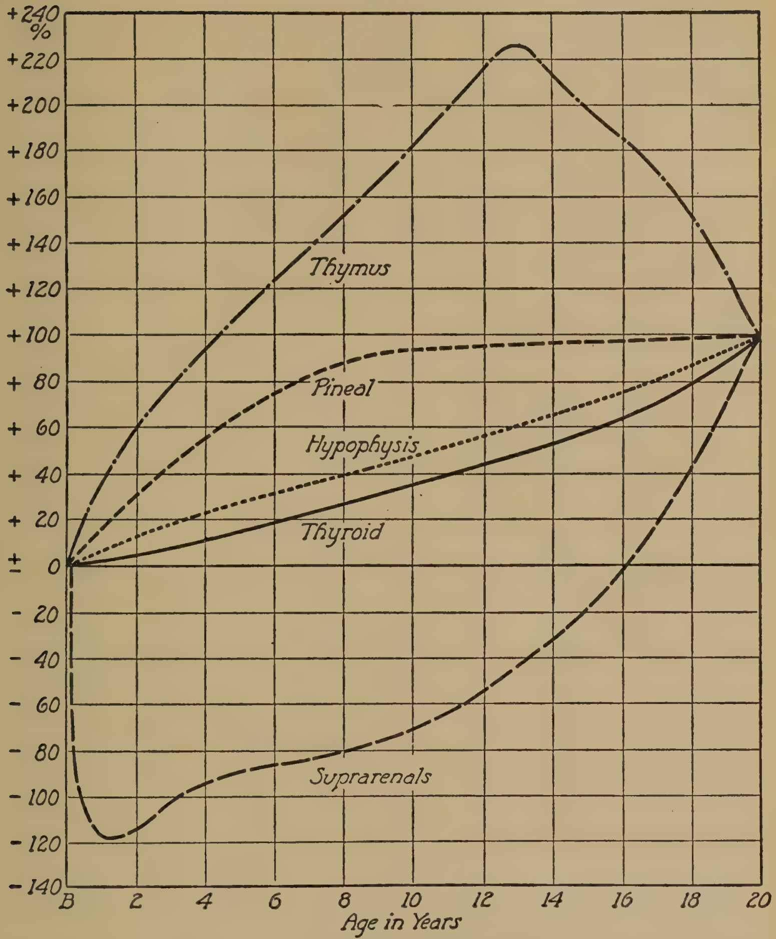

Figure 40. A Diagrammatic Graph Showing the Modes of Postnatal Growth Followed by a Number of the Organs Usually Described as Ductless or Endosecretory Glands

The curves are reduced to a common scale by computing their values at year intervals as percents of their total postnatal increments (to twenty years).

(J. A. Harris *et al.*, *The Measurement of Man*, University of Minnesota Press, 1930)

The Growth of Skilled Movements

Innate Basis of Skilled Movements.—The physical activities of the child at birth are limited to some reflex, instinctive, and emotional acts and others which, for want of a better name, we have called random movements. Under the first class are such acts as sucking, swallowing, patellar and pupillary reflexes, and other simple unlearned responses to specific stimuli. Under the second class come the more complex and less definite responses such as attack, withdrawal, temperature, hunger, and sex. As a rule, in this list we find that the form of the response is not so much inherited as the general tendency. The specific expression of the tendency is largely a matter of learning. Under random movements are to be included all those indirect and seemingly useless movements of hands, feet, body, eyes, and vocal cords. Such movements are not to be looked upon as actions without stimulation but rather as a sort of overflow activity. Some of the common forms of stimulation which cause these are pressure of clothing, digestive activities, and semicircular canal disturbances. Whatever their source, at first, they have little adjustment value for the child.

However, it is from this mass of indefinite and generally inadequate beginnings that skilled movements are developed. In fact, we may define a skilled movement as a definite and successful response to meet the maladjustments of the individual.

The lower animals are born with a group of specific and generally successful responses to life situations. Little learning is necessary and very little takes place. The animal either meets his problems successfully or dies in the attempt. In contrast with this, the human infant is born with very few definitely formed responses but a wealth of possible connections. It is out of these that he later develops his ways of meeting his difficulties. He does this both by learning how to adapt to the conditions he meets and by changing the character of the situation. In reacting to cold he may either put on clothing or build a fire or he may move to a warmer climate. Let us now sketch in some detail the way in which these skills are developed.

Factors in Learning.— The first factor in and the necessary prerequisite of all learning has already been mentioned, in a negative way, as a maladjustment. The same idea may be expressed in a positive fashion as a motive or purpose. There must be a tendency or driving force or there will be no learning. This tendency or motive may be either conscious or unconscious; it may be either innate or acquired.

In order to understand the problem better, let us consider a few examples. The infant is presented with a bright red ball. He reaches or attempts to reach for it but has not developed sufficient coordination to secure it in the first attempt. He continues to try and eventually is able to get it in his hands. Here we can speak of the child being motivated to reach for the ball. This motivation eventually results in the development of skill in hand and arm coordination. Another child begins to steal pennies from his playmates in order to buy candy. The stealing leads to the taking of things of greater value. Eventually he becomes a professional check forger. Let us select another example. The pre-medical student in college finds comparative anatomy very difficult and rather uninteresting, but he realizes its importance in surgery and spends additional time on the course and passes it with a good grade. The question is *why* are these responses first begun and later continued until mastered.

The older method was to explain activity as due to reflexes and instincts. Such an explanation is still satisfactory in many instances, if reflexes and instincts are conceived as types of needs and tendencies and not as forces. But reflexes and instincts do not explain all action. Few would claim that the pre-medical student mentioned above was impelled to study by instinct. It may be that ultimately all drives originate from innate sources; but, if so, the drives are so delayed and indirect that they could hardly be called instincts. Such conditions can only be explained by saying that there is a large learning factor involved in the motive itself.

Thus far, drive has been discussed both in the sense of what starts the learning process and what keeps it going when once it is begun. The first is the problem of original movers to action, while the latter is that of keeping the process going until learning is accomplished.

As Woodworth[8] has so clearly pointed out, motivation is not just a simple matter of stimulus-response. It is a problem of stimulus-organism-response. There is no response without some stimulus. Neither is there a response without an organism present. Furthermore, the character of the stimulus is significant as is also the condition of the organism. It makes a difference whether the stimulus is a loud sound or a cold draft of air and it makes a difference whether the organism is asleep or awake, angry or happy, hungry or satiated. All these factors have their influence upon the response. They determine whether a response is to be made and if so the character of the response. The recurrence of the situation also causes learning of appropriate responses by methods to be described later in this chapter.

This leads to the further problem of motivation. In some kinds of situations correct or appropriate responses solve a difficulty and there is no call for further response until the former difficulty again arises or some new one arises. For example, after the child is satiated, food is not a stimulus to call forth the eating response. There are, however, other situations in which the response does not change the character of the organism. A man who has made some contribution to science is not satiated. He continues to work on the same or other problems. In this sense the drive becomes what we call an ideal—a goal toward which one strives without the idea of attainment or at least of full attainment. These apply in the social, professional, intellectual, and moral realms in particular but are not so essentially different from drives in the lower levels of behavior.

Drives, then, are to be looked upon as movers to action and to the acquirement of efficient modes of behavior which range from reflexes, instincts, and emotions with rather definite modes of response and indirect attainments through more indirect needs, desires, and wishes to unattainable or at least future goals in the form of ideals. They vary from the unconscious, immediately attainable to the deferred and learned forms of behavior. Yet they are all drives and differ mainly in the degree of innate or learned factors involved and not in essential quality.

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[8] R. S. Woodworth, *Psychology* (rev. ed.), Henry Holt & Co., 1929.

Gestalt Theory of Learning.—The problem of learning acts of skill as described in this chapter follows the more traditional treatments of the topic. There is another more recently developed doctrine of learning which rejects much of the orthodox explanation and presents another in its place. This newer explanation is presented by the Gestalt school of psychology.

The Gestalt psychologists emphasize the place and significance of a goal in learning. This goal is conceived in terms of a conscious knowledge of the end to be attained, or insight as they call it. This insight comes as a result of maturation of the nervous system—see Coghill's study of the amblystoma in Chapter 4. Stimuli produce a tension of the body which is resolved according to what is called the law of "least action" into successful responses, that is, certain configurations are broken apart from a background and form the basis for learning. Although not denying the rôle of repetition the Gestalt psychologists say, in a way not clear to the writer, that "repetition induces maturation."

Wheeler[9] summarizes his views as follows:

> The learning process proves to be a form of intelligent behavior that inevitably takes place when the organism faces problem situations repeated at intervals of time. It is a function of (a) maturation, (b) the repetition of stimuli, (c) the time intervals between repetitions of stimuli, (d) the relation of the problem to the learner's level of maturation, (e) the completeness with which the stimulus-pattern is repeated and (f) the degree of tension under which the learner is behaving.

While certain experimental evidence gives credence to some of the contentions of this school of thought, Thorndike[10] has recently cast considerable doubt on some of their premises. The problem of harmonizing the different points of view and discovering the valid parts of each remains for the future.

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[9] R. H. Wheeler, *The Science of Psychology,* T. Y. Crowell Co., 1929, Chs. IX-XI. See also W. Koehler, *Gestalt Psychology,* Horace Liveright, Inc., 1929, and K. Koffka, *The Growth of Mind,* Harcourt, Brace & Co., 1924.

[10] E. L. Thorndike, *Human Learning,* The Century Co., 1930.

Methods of Learning.—Our second problem is how learning takes place. Woodworth has listed four methods of learning. These are (1) strengthening through use, (2) substitute stimulus, (3) substitute response, and (4) combination.

1. STRENGTHENING THROUGH USE. Strengthening through use gives us no new modes of behavior. It only makes facile movements already present as reflexes, instincts, or random movements. Reflexes are not greatly modified. Instinctive movements, as we have pointed out, vary greatly in the way in which the response is carried out. The mode of response is, as a rule, of the trial and error type. Those responses which are successful tend to be strengthened and those which are unsuccessful are discarded. Here we have the basis for real learning.

Random movements also form the basis for much learning. Many of the movements which are useful in life are first made as random movements. When these movements are made in such a way as to produce satisfying results, they tend to become fixed for later use. Just how satisfyingness helps in the fixation process is not certain; nevertheless, the evidence for such fixation is very clear.

Thus, for example, when a red ball is presented to the child for the first time, the child will make all sorts of random responses. Most of these are of no avail. Largely by accident the child may touch the ball. The satisfyingness accompanying this movement tends to strengthen this successful movement more than any of the others. Random movements are very important basal factors in later skilled movements.

2. SUBSTITUTE STIMULUS. The second method by which skilled movements are developed is by substitute stimulus. Substitute stimulus also produces no new responses, but it forms the background for a great elaboration of responses. By means of substitute stimuli a wealth of connections between stimulus and response is formed.

The child at first is afraid of only a few things. He soon learns to fear many others. The hot stove, the sharp knife, the high steps, the approaching automobile, and generally the irate parent become substitute stimuli which call forth the fear response.

But the great field of substitute stimuli is in the substitution of language and later of language symbols, printed words, for objects as stimuli. Such substitution, however, is not so great in the field of skilled movements as it is in the more general field of learning. This discussion, therefore, will be left for the chapter on Learning and Thinking (Chapter 13).

3. Substitute Response. Substitute response is the third method for acquiring skilled movements. By this method certain responses, which innately or as a result of learning tend to be made to certain situations, are discarded and others substituted. Many innate responses are not successful in life situations. For example, in boxing the normal response to a glove or a closed fist coming toward the eye is to close the eyes and dodge. But the person who has had much experience in boxing realizes that this is not the right thing to do. After the opponent's blow has started it is too late to dodge, and to close the eyes is only to allow the opponent to follow up with another blow without our knowing what he is about. Instead the skillful boxer learns to put up his hands for a guard rather than to attempt to dodge the blow; and he must learn to keep his eyes open and upon his opponent at all costs.

Another illustration of a substitute response which must be developed occurs in learning to ride a bicycle. In balancing the body we overcome a tendency to fall by leaning in the opposite direction. In balancing on a bicycle, however, we must learn to lean in the direction toward which we are falling in order to right ourselves. A similar substitution from a learned response is in backing an automobile, an operation which requires a reversal of our normal responses.

Many of our skilled acts are built up in this way. Much of this we work out for ourselves. In other cases teachers and coaches help us in building up our substitute responses.

A special case of substitute response is often called *negative adaptation.* In negative adaptation we learn to suppress the response we tend to make to the situation. Infants are afraid of loud noises. The child learns not to respond to thunder and lightning. The normal boy learns to enjoy firecrackers and toy pistols, although his sister may continue to jump and even cry when he fires the cracker or pistol too near her. The workman becomes negatively adapted to the noises of the shop, and the typist should not spend her time in looking at the callers in the office. In order to prepare his lessons, the student in the study hall, fraternity house, or library must also learn to neglect the many interesting things that are going on about him.

4. Combination. The fourth method of developing skilled movement is by combination. The parts combined into the more complex act may be either reflex, instinctive, random movements, or learned responses. While it is hardly possible to say which of these four methods of learning is most important, certainly this last ranks high. Scarcely a complex act, if indeed any, exists which is not composed of simpler elements. Skilled acts can almost be described as the construction of complex patterns out of elements. Life activity is not a series of separate, discreet acts but rather a composite, a sequence of parts.

For example, a golf stroke is a sequence of stance, grip of the club, back swing, twist of the body, bend of the arms and wrist, completion of back swing, forward movement of arms, swing of the body, and follow through. The beginner must work each of these out or be instructed by the professional. While each part must receive emphasis in the learning, the expert golfer must synthesize all these parts into a unitary act with the ball and its appropriate placement as his objective.

The child in learning to walk has similar problems. Taking the first step is only a part of walking. The first step must be followed by a step with the other leg. During this activity the body must be balanced with a shift in balance from the leg taking the step to the one about to take the step. The elements in walking are a complex of native and acquired parts fused together into a series of rhythmic movements.

The manner in which these parts become fused together is an interesting illustration of learning. This consists not only in the selection of the parts but also of their connection in the appropriate sequence. Trial and error, imitation, and careful analysis generally all have their share in the process. The more skilled the act the more difficult the acquisition.

The Laws of Learning.—The methods by which skilled acts are acquired has just been described. The next problem is how they become *fixed* into permanent habits. The ways by which they become fixed are called the *laws of learning*. These are classified as primary and secondary. The three primary laws are (1) use, (2) disuse, and (3) effect. The secondary laws are (1) primacy, (2) recency, (3) intensity.

The Law of Use.—Whatever the acquisition, the way in which it is made permanent is by practice or use. The child is continually active. He is eternally babbling, moving, and kicking, and, when old enough, walking, jumping, climbing, etc. Whatever is learned is repeated time and again. It is fortunate that the normal child is so full of energy and so ready to repeat whatever is once accomplished. My own son's constant urge, "agin dada," is seemingly only an attempt to get "dada" to manifest this same tendency which he possesses. We marvel at how rapidly the child learns to speak a language or do so many tricks. This is to be explained by the exuberance and persistency of youth, a virtue too often lost in later life. It is not mere accident that most good language enunciation and most games and acts of skill are learned early in life. Who has seen a good tennis player who started playing after the age of 18 or 20?

The Law of Disuse.—The antithesis of the law of use is the law of disuse. One of the characteristics of the nervous system is its plasticity. This plasticity forms the basis for learning. It also permits the loss of function through disuse. It is because of this fact that even the professional pianist, violinist, or football player must continue to practice. After maximum skill is attained, a certain amount of training is necessary to retain the skill. After Paderewski's withdrawal from the stage for his political career he spent several months in seclusion for daily practice before reappearing before public audiences. This was necessary to overcome the loss due to lack of practice on the piano while he was premier of Poland.

There is a peculiar difference between the rate of loss in motor skills and other types of learned responses. Ebbinghaus, Bean, Radassawljewitsch found rapid loss in memory for both nonsense and sense material. Sixty per cent of nonsense material was gone in twenty-four hours; 75% was gone after a month. Memory for sense material did not deteriorate so rapidly, but almost as much was lost at the end of a month.

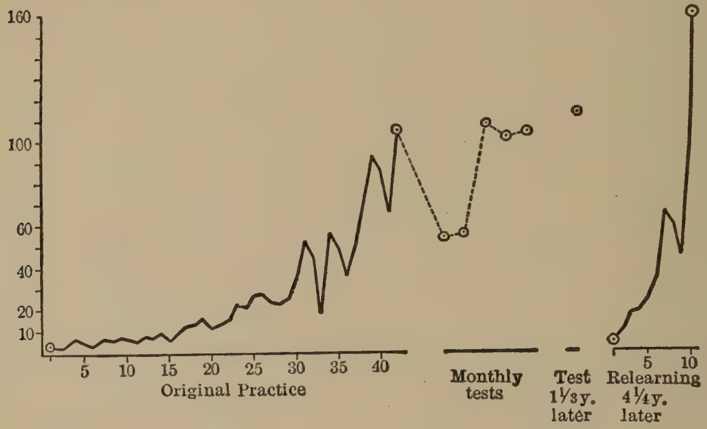

Figure 41. Retention of Practice Effects in Ball Tossing
(Swift, *Am. J. Psychol.*, Vols. 14 and 16, *Psychol. Bull.*, Vol. 7)

In marked contrast with these results are those of Swift[11] in ball tossing. The accompanying curves for the original practice in keeping two balls in the air simultaneously shows only about one-third lost after a month. Later practices a month apart showed practically maximum skill. One and a third years later there was no loss. After four and one-fourth years without practice most of the skill was gone, but only a little practice was necessary to surpass all previous performance. Similar results were obtained for typewriting.

Somehow motor skills once well-learned are almost never lost. As an example of this, who has not seen some old person execute some forgotten dance step or trick of skill? The writer has watched with interest a very old Civil War veteran go through the intricate maneuvers of saber practice. He has himself had the experience of riding a bicycle after several years without practice with very little seeming loss of skill.

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[11] E. J. Swift, *American Journal of Psychology*, Vol. XIV, pp. 201–251; Vol. XVI, pp. 131–133; and *Psychological Bulletin*, Vol. VII, pp. 17–19 (Dashiell, p. 364).

The Law of Effect.—The law of effect has already been mentioned in connection with the methods of learning. Somehow satisfying responses tend to be retained and dissatisfying ones lost. Nature is kind to man in this regard. James, and more recently, Carr has attempted to explain the reason[12] for this. Whatever the reason, Kuo showed that a rat would learn to take the shortest and quickest path to food rather than the longer path or the path with punishment even though by chance any path had an equal opportunity to be learned. Animals including man learn what gives pleasantness at the expense of all else.

Secondary Laws of Learning.—The secondary laws of learning are not really additional principles but rather special conditions of the law of use. The law of primacy states that the *first* experiences in the learning process are more important than later ones. As a corollary of this we may say that the law of diminishing returns begins to be operative. It is important if a high degree of skill is to be attained that right rather than wrong methods be learned. Often the dancing teacher, the golf instructor, or the football coach would rather take the beginner instead of some one who has learned some bad habits. How hard is it for the person who has learned typing by the "hunt and peck" method to learn the "touch" system. Many of us have seen football games lost by a fumble due to improper carrying of the ball, a trick learned on the back lot or under poor coaching.

It is a fact that the child seldom learns right methods in first doing the ordinary acts of skill. He acquires his skill by the wasteful trial and *error* methods. But this is no argument against the law of primacy. It rather explains the usual slow rate of learning. In contrast to this we often see cases of rapid learning under good guidance. Here is a place for the teacher which should not be neglected.

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[12] F. A. C. Perrin and D. B. Klein, *Psychology Its Methods and Principles*, Henry Holt & Co., 1926, Ch. V.

Seemingly somewhat in contrast with primacy is the law of recency. This accounts for the relative ease with which we execute some act while being instructed in how to do it. Who of us has not stood before our golf instructor and driven the ball successfully time after time? Once we got going successfully it was not difficult to continue. Of course, later when we begin to play, all may be quite different. Recency has lost its potency. We have seen basket ball players throw foul goals one after another before the game and then miss them regularly after the game has started. Of course, there are other elements such as excitement and the opposing team, but recency is also a factor.

Intensity is the last of the secondary laws. A boy may practice a back handspring for a long time unsuccessfully, but once he has succeeded in this act of skill, it may become relatively easy for him. He has experienced the thrill of accomplishment. The boy or girl who absorbedly watches a star in some sport executing a skilled act will thereafter, in many cases, be able to copy the act with little or no practice. In such circumstances, there is an intense interest exhibited by the learner. Interest is not a complete measure of the rate of learning but it bears some relation to it.

Learning skilled acts is a difficult task and is not to be explained by any single formula. We have here analyzed the chief features involved. In some cases one element dominates; at another time and place another element takes precedence; but always there are other factors playing the minor rôles. Somehow the child acquires his skills, some much more than others, some in one field and some in another. These are all essential to a rich, wholesome, normal life. The awkward child is seriously handicapped, not only for performing the acts of skill which may be needed to gain a subsistence, but for making successful adjustments to other people.

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CHAPTER 10

PLAY

The Problem.—Any account of the life of the child which does not include play as one of its elements has neglected a most important factor. Play is important not only for entertainment but also as an educating influence. In play the child forms the basis for much of his later life activities. This is especially true in regard to his physical development, but it is also true of his emotional and intellectual development. There no doubt was some truth in the statement attributed to the Duke of Wellington that "the battle of Waterloo was won on the playing fields of Eton." Excellence in art and literature continue to be won on the basis of the spirit of play rather than as a result of drudgery. Even intellectual and industrial battles continue to be won in accordance with the principles and practices evolved on the playground, diamond, tennis court, golf course, and gridiron. There is a recognition of this fact in the practice of some large industrial companies in selecting college men who have excelled as much in play as in the classroom.

While work and play seem as far apart as the poles, when we try to distinguish between them many difficulties are encountered. If we see a boy stacking a pile of brick, we may not be able to tell whether he is building himself a house or has been set the task of arranging the brick by his father. In the first instance it is play, in the second it is work. A boy walking across the fields with his dog may be going hunting or going after the cows. If he is hunting he is playing: if he is going for the cows it may be work or it may be play. The real distinction is the attitude toward the act.

When the motive is some utilitarian end or when the task is set by another for some such end, it is work. When the end is indirect, as will be described later, or when the task is carried on for the pleasure involved, it is play. In some cases the distinction is not clear. In others the motives are mixed. Such cases present difficulty in judging whether the task is work or play.

A further difficulty in deciding between work and play is encountered in such things as reading, writing social letters, and playing musical instruments. Yes, even the daily task of the office or home may take on much of the zest and spirit of play. Difficult as these problems are, the same criterion is to be used here as in the other cases.

Some of our athletes, especially football men who spend five afternoons per week from September to December and from April to June in practice and every Saturday during the playing season in contests, come to wonder whether they are playing or working. When driven by the modern coach, with the honor of their institution as well as their own personal honor at stake, much of the spirit of play is lost. Truly, what seems to be play often is not play, and what often appears to be work, if not play, possesses many of its essential features.

This chapter will differ somewhat from the other chapters in this text in that little space will be devoted to the play of lower animals and to the play of primitive man. There are two main reasons for this deviation from the general plan for the text. Although Groos and Hall have studied the play of animals and others have studied the play of savage tribes, these studies do not contribute much to our present problem. Secondly, the play of the modern child and adult is so much conditioned by social influences—that is, it is so distinctly a group activity—and it is so much dependent upon modern equipment—toys, bats, clubs, balls, etc.—that present-day play bears little relation to the play of animals or early man. It is only in the play of infancy that much similarity exists, and here we can learn more from direct observation and study than from inference from the play of animals or otherwise.

Hence we shall attack the problem of play more directly than genetically. However there are several respects in which it may be considered as a genetic approach. Consideration will be given to the theories of the origin of play. Several of the studies of play will report age changes and differences in play. In these ways considerable attention will be given to the genetic aspects of play.

Theories of Play.—Herbert Spencer,[1] following the suggestion of the poet Schiller, thought that play was the release of surplus energy. The child has a great abundance of surplus energy. The appetite is good, digestion is good, and the child builds up a great supply of energy. Play constitutes a common outlet for this energy. As further evidence of the relation of surplus energy and play we need only to note the fact that sickly children are not nearly so likely to play as healthy children. Adults do not play as much as children because they have less surplus energy.

But there are two or three important objections to the Spencer theory. It does not tell us why play activities take the forms they do. If it were merely a matter of relieving energy, work would be just as effective as play. While there is some element of truth in this statement, every one knows from his own experience that work is not an adequate substitute for play, either in the child or adult. After a hard day in the classroom, office, or shop most healthy children and adults welcome a period of play.

There is another criticism of this theory. If it is only for a release of surplus energy, the child would play until this energy was exhausted and then stop. But we know that the child engaged in interesting play will continue to play until almost completely exhausted. Even adults may play tennis much beyond the point that is good for them or in golf or hunting they may walk until they can hardly go farther. Therefore, some other factor than surplus energy must be introduced to explain the form of expression of this energy and to account for a continuation of the activity after the surplus energy has been consumed.

Karl Groos[2] has explained play as a preparation for life. In his study of the play of animals, of savages, and of children he found that play was similar to what the animal or person did later in life. The child instinctively plays at what later is to be his work. Those animals and persons who while young play at activities which they take up in later life are best fitted for the serious tasks of life.

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[1] H. Spencer, *Principles of Psychology*, D. Appleton & Co., 1st ed. 1855, last ed. 1914.

[2] Karl Groos, *A Comparative Study of the Play Activities of Adult Savages and Civilized Children*, University of Chicago Press, 1910.

The criticism of this theory is that it confuses the cause with the effect. Preparation for life work is a result and not a cause of the play of the child. Furthermore, some play has no utilitarian value. Sometimes it is even detrimental to later life work.

Another theory which has attracted much attention is the recapitulation theory of G. Stanley Hall.[3] This writer goes into detail to show how play expresses the earlier forms of animal life which the child's life parallels. In play "we rehearse the activities of our ancestors, back we know not how far and repeat their life-work." The order of unfoldment follows the evolution of the race: that is, the earlier play of the child simulates the lower animal forms while later play resembles the activities of the higher animals.

One great criticism of this theory is the fact that much play does not resemble in any way the activities of animals. What period of animal life is paralleled by riding on skooters or tricycles or by playing marbles? Further criticisms of the general theory of recapitulation will be given in Chapter 16.

McDougall[4] believes play is an expression of the instinct of rivalry. In play we have one form of expression of this instinct. This impulse is further strengthened by the "growth of self-consciousness." McDougall substantiates his doctrine by telling that the hybrid Papuan-Melanesian peoples have a very weak instinct of rivalry and it was almost impossible to teach them to play. It should be explained that McDougall is discussing the higher types of play and not the free, spontaneous activity of early childhood.

This last statement is the first criticism of the theory. At best it explains only certain types of play. Furthermore, it is based upon the very questionable hypothesis that rivalry is an instinct. It is also true that, whatever rivalry is, it is not limited to play. Any such explanation, therefore, should show just where rivalry leads to play and where it leads to some other type of activity.

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[3] G. Stanley Hall, *Adolescence,* D. Appleton & Co., 1904, Vol. I, p. 202ff.

[4] Wm. McDougall, *An Introduction to Social Psychology,* J. W. Luce & Co., 1927.

Robinson[5] has explained play as a compensatory make-believe activity. He says that the child may have a desire to kill game, but there is no game present and no gun with which to shoot the game if it were present. So the child plays that the pet cat is game and that a stick which is handy is a gun. Thereupon the child proceeds to point the "gun" at the "game" and yell "boom." Robinson shows that many games, such as baseball and boxing as well as playing with toys, are a form of make-believe.

This theory is very satisfactory in explaining certain types of play as described above. The great criticism, as of some other theories, is that it does not explain all kinds of play.

We are here proposing an extension of this theory somewhat modified by Thorndike[6] but in some respects unlike either. In many life situations there is an original connection between stimulus and response. This is not necessarily saying that there are a lot of instincts, but it does infer that there are original tendencies upon which activity is built. Whenever the external stimulus is strong enough and the internal condition favorable, a direct response will follow. If, on the other hand, there be no strong tendency to a specific response, the stimulus may lead to a less specific, indirect, or make-believe response. When a hungry kitten catches a mouse, it will proceed to eat it. If in the process it becomes satiated before the mouse is eaten, it is likely to play with what is left. In like manner, if the baby is presented with the bottle and is hungry, it will drink. If not, it will play with the bottle. If the drive to specific activity is strong, a direct response is made: if the drive is weak, and there is a surplus of energy or a suggestion from another person, the expression may take the form of play. This same idea may be expressed in another way by saying that the intention or the purpose of the activity determines whether the act is play or work. If the end is direct or to attain some definite end or the fulfillment of some need, the activity is work. If it is indirect or to secure some function other than a definite need, then it is play.

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[5] E. S. Robinson, "The Compensating Function of Make-Believe in Play," *Psychological Review,* (1920) Vol. 27, pp. 429–439.

[6] E. L. Thorndike, *Educational Psychology,* (briefer course) Teachers College, Columbia University, 1904, pp. 66–68.

Forms of Play.—Such a description may account for the tendency to play, but it does not explain the form which it will take. The young infant just plays. It may play with its hands or feet, the bed clothing, anything which has been given to it, or it may just kick and laugh. Out of this simple beginning more complex forms of play and games develop. The forms of these higher types of play depend upon training. The child learns to play with toys and how to play with them. The child learns to fondle the doll or throw a ball. The suggestions of others often determine the form of play and even accentuate the spirit of play. When the neighbor boy comes along and calls "Come and let's play ball," then it is with great difficulty that the growing healthy boy can resist the temptation to play ball. The form of the play depends upon the past experiences, the interests, and the immediate circumstances of the child. This topic will receive further consideration in a later part of this chapter.

What are the immediate types of stimuli which call out the play response? It has just been said that almost any simple object is sufficient. Woodworth[7] says play generally depends upon a toy. He describes a toy as (1) little models of articles used by adults, such as a doll and small furniture, (2) things which increase speed of movement, such as skates, or movement in unusual ways, as jumping, (3) things which increase the radius of action, as balls to throw or bow and arrow, (4) things that resist gravity, as balloons, kites, and aeroplanes, (5) things that move in surprising ways, such as a boomerang, tops, and mechanical toys, (6) things which can be opened and shut as a book or a box, (7) plastic materials like sand, snow, or clay, and finally (8) playmates.

The thing which most interests the child as well as the type of response which he makes toward the objects differs greatly with the age, sex, and intelligence of the child.

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[7] R. S. Woodworth, *Psychology*, Henry Holt & Co., 1930.

Mary Whitley in a chapter in *The Child, His Nature and His Needs*[8] gives an excellent account of the age differences in play interests.

> An instinct that may be seen functioning in many kinds of play is that of habitation. The wee toddler discovers delightful niches and cubby holes into which he will crawl with manifest pleasure. By three or four, children may see the value of forming an enclosure with chairs, and show every evidence of contentment at sitting safely esconced within. The tent of the pendant tablecloth, the shelter of rugs or sheets hung on the laundry line, the empty crate, the dog kennel, have irresistible charms for the smaller children. After five or six, the boys are more active in constructing their habitation. As observed in the kindergarten, about four boys to one girl will work persistently in erecting a play house. Problems of openings for doorways and windows, even of hoists and elevators engross the men of the future, while the women wait aloof. When all is finished, however, it is the latter who will promptly move in with their doll family, and realize the need for cookstoves, beds, and curtains at the windows.
>
> This difference in interest is maintained during the next few years. It is the girls who modify the boys' effects by decorative ventures in roof line and color scheme. After the age of eight or so, each sex follows its respective bent separately, unless it be for very temporary purposes in the hay mow, the sand heap, the snow fort, or the wood pile. Little girls' outdoor retreats are frequently simply a secluded spot under the bushes, in the area way, in an angle of the rocks. On a bare surface sometimes the walls are merely marked out by lines, and the edifice left to the imagination: but furnishings will somehow be found, and perhaps a "garden" will be added, made with stones, leaves, colored fragments of glass and china. Boys will prefer to build, using any material handy. In the woods a wigwam will make its appearance: on the hillside a scooped-out cave. On the city lot old tins hammered out flat, odds and ends of tar paper, linoleum, matting and of course barrels and boxboards can all be utilized. By ten or eleven, the shelter is a stronghold or hangout for the group whose password identifies them, and who share many joys there together, from simple cooking to thrilling narrative. After twelve or thirteen, children lose interest in this make-believe house and begin to take pride in their real club quarters. Girls too, and boys later, wish to transform their own private rooms at home. By seven-

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[8] M. V. O'Shea *et al.*, *The Child, His Nature and His Needs,* The Children's Foundation, 1924, pp. 59–60.

teen or so, a keen rapture may come from refurnishing and decorating the adolescent's room according to his or her own tastes.

Experimental Studies of Play.—Not only is this a very clever analysis based upon an observation of children at play, but it is substantiated by several studies of an experimental character. Croswell,[9] Johnson,[10] McGhee,[11] and Lehman and Witty[12] have each contributed to the facts of age differences. The following chart from Croswell shows the decline in interest in toys for both boys and girls, the rapid rise of interest in ball games for boys with little interest at any age for girls, and the rise and decline in interest in games of chase for both boys and girls. These results were taken from a study of 2,000 Worcester school children. In a study of rivalry and cooperation in play McGhee found rivalry much stronger in boys than in girls with little increase from age to age. This is to be contrasted with a rather rapid increase in cooperation in which girls were much below boys at age 6 but slightly exceeded them at age 18.

Johnson traces the development of self-consciousness in play. At first, play is exclusively individualistic. The child plays by himself with toys. He may be interested in having other children or adults near or they may enter into his play. However it is, he plays for himself and is sure to resent it if others get in his way. If other children get his ball and it is not given to him immediately, he cries or starts a fight.

The first period is followed by play of groups, but the *group is small and indefinite in number.* While there is congregation, there is little cooperation. The play is not a game in the sense that there are no fixed rules or definite goals. Children of this age are likely to imitate the actions of older persons. They play keeping house, store-keeping; characters from nursery rhymes and stories are portrayed; and the funnies in newspapers and radio skits furnish fertile themes for play at this age. Such

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[9] T. R. Croswell, "Amusements of 2,000 Worcester School Children," *Pedagogical Seminary and Journal of Genetic Psychology,* Vol. VI, pp. 314–371.

[10] G. E. Johnson, "Education by Plays and Games," *Pedagogical Seminary, etc.,* Vol. III, pp. 97–135.

[11] J. McGhee, "A Study in the Play Life of Some South Carolina Children," *Pedagogical Seminary, etc.,* Vol. VII, pp. 459–478.

[12] H. C. Lehman and P. A. Witty, *The Psychology of Play Activities,* A. S. Barnes & Co., 1927.

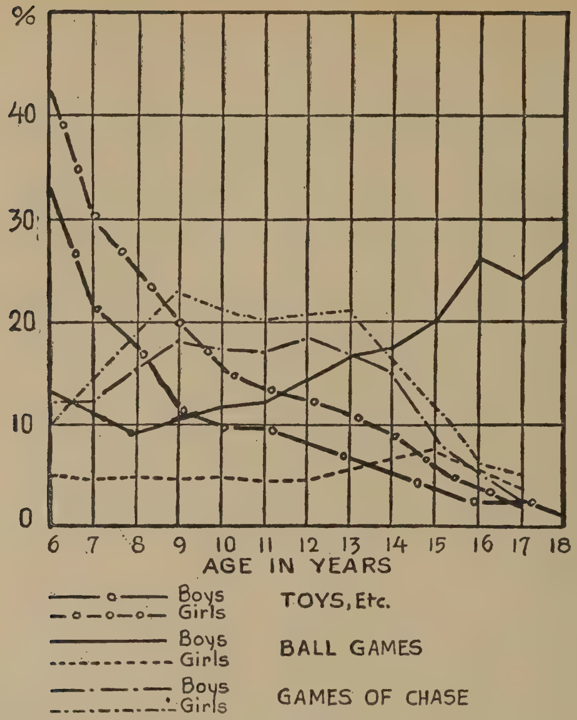

Figure 42. Interest in Various Games. (After Croswell)
(*Ped. Sem.*, Vol. 6, p. 330)

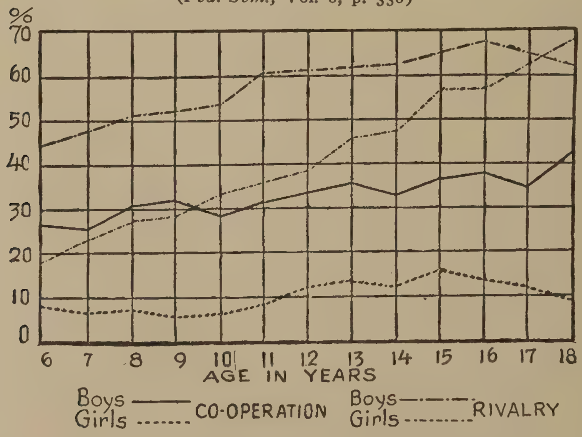

Figure 43. Cooperation and Rivalry in Play
(McGhee's study, *Ped. Sem.*, Vol. 7, pp. 459–478)

simple dramatization shows vivid imagination and clever originality in such representations.

The next form of social consciousness shows in rhythmic movements and singing games. Games such as "drop the handkerchief" and "the cat and the mouse" are common. Here we see the beginning of active competition. The next stage introduces the idea of two sides, the *double group* game proper. Such games may be for two or four or more people but generally in pairs. The game has rules and methods of scoring.

The next and highest form of game is the *team game,* such as baseball, football, volley ball, or bridge. Two groups are contending as in the preceding type, but cooperation between the members of a group is necessary. Individual interests must be subordinated for group success.

These three studies were conducted by the questionnaire method and are subject to all the inaccuracies of such a method. More recently Lehman and Witty have made a more exact study of some of the same and related problems by checking from a printed list of 200 play activities. This study was carried on with boys and girls from age 5 to age 22 in several Middle Western states. They also studied differences between country children and city children, and between negroes and whites. Their results may be summarized briefly by saying that no strikingly new facts about age differences in play were brought out. They stress the continuity and permanency of play interests and the more "conservative" play of older children and adults.

These writers found less difference between the sexes in play than has been found by previous studies. The largest sex differences occur between the ages of 8½ and 10½. They make the rather surprising statement that as the chronological age increases the sexes tend to engage more frequently in the same activities. Consequently sex differences are not so pronounced at the higher age levels.

In their study of country and town children, several more or less obvious facts were brought out. For example, town children go to the movies much more often than country boys and girls. As contrasted with this, country boys go hunting much more often than town boys. Town children ride bicycles more while country children ride horseback more. The median number of play activities of the two groups is not significantly different. Town boys play more up to age ten than country boys and less during the years thereafter. A similar change between town and country girls was found, but it occurred at an earlier age. These writers find rather interestingly that country boys whistle most and country girls do the most spontaneous singing.

Several inherent difficulties prevented a satisfactory comparison of the play of negroes and whites. One significant fact brought out by the study was the greater sociability of the negroes in play. The differences are marked and consistent from year to year. Negro children go to church and Sunday School—if this can be called play—more than white children. Negro children, for rather obvious social and economic reasons, spend less time in riding in an auto, assembling radios, watching athletic sports, and playing basket ball.

Significance of Play.—The significance of play in the life of the child and in the life of the adult must not be minimized. Play is a factor not only in the physical well-being but in the social and moral well-being as well.

When we see the many stoop-shouldered and otherwise ill-formed bodies of youth and adults we begin to realize how faulty and inefficient our physical training is. Another way in which these facts were brought home to us was the fact that practically one-fourth of the men of eligible age were rejected in the draft for the World War as physically unfit.

The trouble is not so much that we do not have enough physical training and athletics but that it is often of the wrong kind and does not reach many who need it most. Instead of being interesting, much of our gymnastics is shunned by all who have any means of escape. The training is formal and boring. Physical education is one course which freshmen try hardest to avoid in college. This is not because freshmen are lazy but because they object to the formality of the courses. In contrast with this are some of the organized intramural sports which sometimes may be substituted for formal gymnasium courses.

Then again, as now organized, in many grade schools, high schools, and colleges, athletics are arranged primarily for teams which compete with teams from other schools. The rest of the student body get their athletics vicariously. The result is that many get little or nothing and some get too much. The ones who get little or none are often the ones who need it most. The number of athletes who develop "athletic heart" or have some form of physical breakdown when they quit their athletics is so large that it must not be neglected. Somehow we should get back to something like the practices of the Greeks during the classical period. Everybody should learn how and when to play. Those who have defects should be given corrective training. When that time comes athletics will have found its true place in life.

Physical health, important as it is, is not the only value to be derived from play. As pointed out earlier in the chapter, play in all its higher types requires social cooperation. The person who plays successfully must learn how to lead as well as how to cooperate. With our present organization the hero may receive rather bad training. He may get too much training in leadership and not enough in cooperation. He is even more likely to be ruined by hero worship. How hardly can the athletic hero in our colleges and universities live a normal life! The fault lies in our present organization, not in the play itself.

Another value of play closely related to, if not identical with, the above is the moral effects of play. It seems almost tautological to say that play should teach the principles of fair play—to play according to the rules of the game. Contrast with this idea, however, the practices in many forms of athletics. Who ever saw a football player approach the referee saying, "I held on that play," "I tackled that player before he received the pass," or "I stepped out of bounds"? Players are not coached to make such confessions. Too often they are coached to conceal as much as they can. Sometimes they are taught methods of clever infringement of the rules. This holds too often in the great major sports. It is not so true of other types of athletics. Often in tennis each man keeps his own score and passes on whether the ball is outside or inside on his side of the court.

Even if there is a referee the players cooperate in helping with decisions. This also holds for golf. Not that either of these extremes always obtains, but nevertheless they are tendencies. It would be most interesting to study the moral effects of these two types of training, especially on growing children.

Without necessarily subscribing to Groos' theory of play, a good case can be made for the educative value of play. The most obvious value is the physical health of the person who plays. Another less important value is the knowledge of information about play. Play is enough of a factor in life that an educated person should be able to talk and understand facts about play. The sport sheet is often the most popular part of the daily paper.

A less easily defensible position but nevertheless tenable one is that there is a direct value to thinking in having a healthy, vigorous body. This is certainly a natural inference from modern behaviorism. This does not mean that the weak and infirm cannot think. However, there is no question that, when disease becomes severe, the capacity for thinking is hindered.

Another evidence for this point of view is the fact that Terman found in his study of geniuses (see Chapter 12) that they were physically superior to his normal group, their health was better, and they gave general evidence of physical well-being. It seems reasonable to suppose that neither health nor intelligence were directly the cause one of the other. They are reciprocal factors, each in turn influencing the other.

In this chapter we have sketched several theories of play: the chief causes of play for different children have been presented; and the typical forms of play for each age have been discussed. In the discussion of the place and value of play the beneficial effects have been stressed. The inherent faults of modern athletics have come in for their share of criticism. It is the hope of the future that our educational organizations and institutions will devise methods for conserving the values now attained and correct the faults too common in modern practice. When such a day arrives, every person should know how to play and realize the large place of play in the life of every healthy individual.

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CHAPTER 11

MUSIC AND ART

What Is Music and Art?—There are a good many elements in common between play and the topics to be discussed in this chapter. They are both somewhat spontaneous in character but in their higher forms demand considerable direction of some kind. Neither, as a rule, is strictly utilitarian and is more or less hampered when it becomes utilitarian. It is very difficult to draw any clear line of distinction between them. Play probably is more likely to be expressed in gross movement and it is more likely to be performed primarily for the participator. These are only general distinctions and there are almost as many exceptions to these principles as there are illustrations of them.

The form of behavior to be described in this chapter is sometimes characterized by the general title of art. It is not easy to state just what is meant by this term but some of its common forms are drawing, painting, dancing, sculpture, poetry, drama, and music. Although there is much in common in music and the other forms of art, there are enough differences that it seems justifiable after a general introduction to the subject, to discuss music and the other forms of art separately.

The Origin of Music and Art.—Whether the various forms of expression of art had a common origin or different origins is not known. If there is a common origin, that origin is unknown. There may be an innate tendency toward certain principles or forms of expression which we call artistic. However, it is certainly true that much of our idea of art and beauty is a matter of training. Some writers have expressed the idea that art for early man was a method of worship. It was his method of placating, appeasing, and revering his gods. Such an explanation does not show why such worship took such particular and distinctive forms. Neither is there any certain knowledge as to what constituted the first form of art. Grosse[1] believes that personal adornment was the first form of art. If this be true, it is improbable that its earliest purpose had much to do with religion.

Art may be classified into two classes, the arts of rest and of motion. The former may be further subdivided into plastic and graphic arts. Pottery and sculpture are examples of plastic arts. Drawing and painting are examples of graphic arts. Music and dancing are two common forms of the art of motion. While several different forms of art will be considered, music and drawing, as representatives of each of the large classes, will receive chief consideration in this chapter.

As in the study of many of the other problems of phylogenetic development, we may examine the relics of the past or we may study retarded races of the present. Each method has its contributions and each its limitations. We cannot tell how representative the remains of what existed in the past are, and we do not know how nearly the art of retarded races resembles that of early man.

If we are liberal enough in what is called art, the artifacts of prehistoric man constitute our first relics. These, however, can hardly be called works of art. They are rather tools, first largely unfashioned and later shaped for greater effectiveness. Crude pottery has also been discovered with the remains of some of the later prehistoric races. Drawings evidently executed by early man have been found in caves in various parts of Europe. Some of these were done in colors. The drawings represent real works of art, however crude they are.

Music

The Nature of Early Music.—Herbert Spencer[2] following Dubos believed that the musician imitates the sounds of nature in tone, accent, and modulation, just as the painter imitates color and form. Music grows out of language, the stronger emotions receiving emphasis and pitch qualities. Music is emotional speech.

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[1] Ernst Grosse, *The Beginnings of Art*, D. Appleton & Co., 1897.
[2] Herbert Spencer, *On the Origin and the Function of Music*.

Other views hold that music is of different origin and is not an imitation of natural sounds. Schopenhauer expressed it that music could exist independent of the visible world and bears no relation to real objects.

Although our earliest records are of instrumental music, it seems certain that vocal music preceded it. Music was well developed before the earliest records of it as found in Egypt, Assyria, and China. The evidence from primitive peoples is strongly in support of vocal music accompanied by dancing as the earliest form of musical expression.

Egyptian Music.—Our earliest records are from the tombs of Egypt and probably date from about 3000 B.C. These records are mostly on the sides or walls of the tombs and take the form of drawings picturing the life of the people in great detail. Some of the records are accompanied by hieroglyphic inscriptions. In some cases the musical instruments themselves are found in the tombs. In the tomb of Rameses III elaborate stringed instruments were portrayed. Evidently these were played by members of the highest priesthood. In one of the tombs at Thebes, one of the early harps was found with strings of catgut intact. We are told that when plucked these still gave out musical sounds, although the harp had probably not been played for 3,000 years.[3]

Music in Egypt was of sacred character. It was used chiefly in connection with worship of the gods. Sometimes it is represented in connection with patriotic celebrations. Often orchestras of hundreds of musicians are represented.

From the character of the instruments something can be learned about the nature of the music. These instruments were mostly stringed, like the harp and the lyre, but wind instruments of a pipelike character are also shown in the drawings. Many of the instruments had resonance chambers of gourds or of parchment or leather stretched from a wooden framework. In such cases tones of good quality could be produced.

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[3] Marion Bauer and Ethel Peyser, *How Music Grew,* G. P. Putnam's Sons, 1928.

The Egyptian scale was made up of steps and half steps not greatly different from our own scale. The pitch of the instruments could not have been high, since the form permitted the neck of the instruments to bend and therefore the strings could not be stretched tightly. Some of the harps contained twenty or more strings of different lengths, therefore several different octaves were used. Rhythm was predominant in the music, while harmony was somewhat defective.

Assyrian Music.—Assyrian music was of later origin and presented some advances over Egyptian music. The Assyrians had drums, wind instruments, such as flutes and double flutes, and stringed instruments, such as harps and lyres. Because they migrated often, the Assyrians used instruments which were small and easily carried. Martial music was common to the Assyrians. Drawings show that they kept time by movements of the feet.

Hebrew Music.—Through contacts with the Egyptians and the Assyrians the Hebrews borrowed much of their music from each. The Bible tells the large part music played in the lives of the Hebrews. Music was chiefly used in religious ceremonies but also in other celebrations and for enjoyment. Drums and wind and stringed instruments in large numbers and varieties were used. Timbrels, trumpets, the lyre, and the psaltery are often mentioned in the Bible accounts. Samuel, David, and Solomon, in addition to being great heroes, were great musicians. The psalms give us a good idea of the character of their later music. Of course, we do not know just how they were sung, even though we know the instruments used and the nature of the song.

Chinese Music.—Chinese music was, no doubt, of as early origin as the Assyrian. It was not so emotional in character and was more of a noise type. Drums were used as well as stringed and wind instruments. Eight different types of music sources are mentioned in Chinese mythology. These are sounds produced by (1) stretched skins, (2) stones, (3) metal, (4) baked clay, (5) silk strings, (6) wood, (7) bamboo, and (8) calabash. This shows the richness of types of tones and the versatility of the Chinese in producing music. The Chinese first had a five-step musical scale. Later, about 600 B.C., they developed a seven-step scale. Their versatility along this line is attested by an author[4] who says they had as many as 84 different scales.

Origin of Greek and Modern Music.—The largest single contribution to modern music comes from Greece. Early Greek music contained some original material. It also borrowed freely from Egyptian sources by way of Alexandria. Even the word *music* comes from the Greek. To them it meant all of the cultural subjects, including drama.

By most writers Greek music as such was believed to have originated from their gods. Apollo was the god of music. The use of music was not limited to religion, however, as it was used in their festivals and in daily life, later becoming part of their dramas, which were chanted. Instrumental music was also common, many different kinds of instruments being used. The commonest instruments were the lyre and the double lyre.

The Greeks had three musical scales based upon the tetrachord. These were the Dorian, the Phrygian, and the Lydian. The modern octave was developed from a double Dorian tetrachord about 600 B.C. It was probably the outgrowth of the music as played on a double lyre. This produced the octave of six full steps and two half steps.

The mathematical basis for the octave was first worked out by Pythagoras. No doubt he got many of his ideas about music from his long studies in Alexandria. These principles were based upon the relationships of tones from a plucked string. The octave as it was discovered was produced by shortening or lengthening the string by one-half its length. Other points of the octave were found to be fractional parts of these values. The first full step was found to be produced by a string about eight-ninths the length of the original tone.

The Romans borrowed their music from the Greeks and did little to improve it. With the Christianizing of the Roman empire, music became much more important as a part of the religious ceremonies. The church hymns were developed largely from Greek origins. We are not here concerned with the growth of church music as such. Neither can we give space to the development of the different forms of music such as the epic, the ballad, the lyric, drinking and dancing songs, the march, and other forms of music.

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[4] Bauer and Peyser, *op. cit.*

Suffice it to say that music was first closely associated with dancing and largely rhythmical in character. Harmony at first was poor. Only relatively late in musical history were the symphonic possibilities of music discovered and used.

In a study of the music of the Eskimos, native Australians, and the Indian these facts are clearly brought out. These peoples use the drum very extensively for their music. In many cases some crude form of drum is the only musical instrument. It is questionable whether this feature is not more developed in the music of backward races than in early music.

Grosse[5] summarizes the characteristics of primitive music as follows:

> In the lower grades of culture vocal music predominates over instrumental. Both move simply—in short, one-part melodies. Polyphony and symphony are unknown. Of the two factors of melody, rhythm is predominantly developed, while harmony is very defective. In respect to the latter feature, the primitive melodies are distinguished from ours —besides the difference in intervals—first, by a smaller range of tones, and secondly, by the weakness of the pitch.

Children's Music.—While children sing and singing has been taught in the schools for a long time, few studies have been made in this field. Miss Gates[6] made a study of the musical interests of 2,000 children from 6 to 16 years of age. She found, as might be expected, that young children liked lullabies best. School songs are best liked in the earlier grades. Patriotic songs hold a high place all the way along. Street songs are best liked in the middle grades and home songs gain in interest from the earlier to the later grades. There is not much difference between the interests of boys and girls. This study has all the limitations of the typical questionnaire method.

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[5] Grosse, *op. cit.*, p. 291.

[6] F. B. Gates, "Musical Interests of Children," *Journal of Pedagogy*, (1898) Vol. 2.

Seashore Music Tests.—A more recent study of music conducted under more carefully controlled conditions was performed by Dean Carl Seashore.[7] Seashore studied the significant factors in musical performance. He then constructed five phonograph records for measuring these abilities. These tests consist of tests for (1) pitch, (2) intensity, (3) time, (4) consonance, and (5) tonal memory. Norms are presented for different age groups and adults. In general, those making less than 70% on these tests are advised that it is not likely that they will be able to make a success of music. Many other studies of musical ability and musical analysis have been made by students of Seashore, but these are too technical for inclusion here. For the most part, these are concerned with the elements, such as pitch, volume, and vibrato in good singing.

Instruction in Music.—Music teachers differ as to the value of early training in singing. Some believe there is little value to be attached to singing much before adolescence. There may be much truth to this, if the primary interest is in producing finished musicians. Relatively few youthful prodigies make great soloists. However, there is another value to be attached to music and musical appreciation. A distinction should be drawn between musical performance and musical appreciation. Yet a better appreciation generally accompanies some ability at performance.

In most progressive school systems music is taught in the lower grades and in the kindergarten. Instead of being of the older formal type, most of this training consists in free easy singing. Interest in both musical performance and in the appreciation of music is thereby developed. In the upper grades some children will have lost this interest. Nevertheless, there are many who continue their musical training into later years. Most of our colleges have glee clubs, bands, and orchestras which are continuations of these early interests.

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[7] C. E. Seashore, *The Psychology of Musical Talent*, Silver, Burdett & Co., 1919.

Experimental Studies in Music.—Experimental studies in the field of music are surprisingly few in number and meager in results. One of the largest collections of such studies is reported by Schoen.[8] He summarizes studies by Gatewood, Washburn, Schoen, C. S. Myers, Gilliland and Moore, and Hyde. These studies were carried out on adults, but, for the most part, the results are significant for the purposes of the present discussion. The principal problems studied in these investigations were concerned with (1) types of listeners to music, (2) sources of musical enjoyment, (3) mood effects of music, (4) organic effects of music, and (5) effects of repetition and familiarity. The first three of these were studied by controlled introspection methods and the last two by the experimental method.

Myers found characteristic differences between people of different training and interests in listening to music. He classified listeners into three types: persons without musical training or interest, persons of average musical ability, and trained musicians. The first type, he suggests, is interested only in the sensory elements of music. Such persons get little other than simple rhythms and tone values out of music. Better trained persons have certain associations aroused by music. In their accounts of listening to music, they tell of the various kinds of imagery aroused by the music. These associations are often very rich and vivid. These same facts may be stated in another way by saying that the music has meaning for such listeners.

For the skilled musician this association is not so great as for the average listener. The trained musician may study the structure of the selection or the technique of the performer. This is the critical attitude. Such a listener may get great enjoyment or distress as the case may be depending upon how he is satisfied or how the music agrees with his own ideas of good music. If such persons do not take a critical attitude toward the music, they may get pure enjoyment from listening, without any or at least with very few associations. This certainly approaches the doctrine of imageless thought.

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[8] Max Schoen, *The Effects of Music,* Harcourt, Brace & Co., 1927.

Myers also speaks of a "mystical" or ecstatic character in music. Such a character tends to obliterate the usual relations between self and environment. He believes this the essential condition for the appreciation of beauty.

The Enjoyment of Music.—In a further study of a somewhat similar nature, Dr. Gatewood analyzed the nature of musical enjoyment. She found that music arouses definite emotions. Those selections which arouse more and varied emotions are enjoyed more than those that arouse only one or no emotion.

She also studied what emotions were aroused in a group of girls by a number of varied but familiar phonograph records. A rather high agreement was found in the emotions[9] aroused by any selection; that is, some selections tended to arouse sadness, happiness, relaxation, or stirred states, and there was general agreement in the emotion reported even though these were not specially trained musicians.

Mood effects were studied in a similar manner. This study showed that the same effects tend to be experienced upon hearing a musical selection at different times. Music will change one mood into another, whether the mood of the music is restful or exciting. Rest is the most frequent mood aroused, but amusing and physically stirring selections arouse the largest agreement among hearers. Such effects are produced in greater degree by vocal music, but they are also produced by instrumental music.

As at least a partial explanation of these emotional and mood states Miss Hyde studied the effect of music upon blood pressure, heart rate, and the "psychogalvanic reflex." She used both trained musicians and those not interested in music. When "tragic minor tones" from Tschaikowsky's Symphony Pathetique were played, they "lowered the functions especially considered" in her investigation for the musically trained listeners. The untrained were not affected. The Toreador song from Carmen increased these functions in musical persons, as did also Sousa's National Emblem March. No effects were apparent with the unmusical group.

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[9] Emotion and mood are here used in a somewhat unusual sense.

Effects of Different Kinds of Music.—In some experiments conducted by Miss Washburn and by Gilliland and Moore, the effects of repetition of popular and classical selections were studied. At first the popular selections had a stimulating effect upon listeners. The heart beat faster, the strength of grip was greater, and steadiness was improved. The classical selections did not have much effect except on the musically trained listeners. As these two types of selections were repeated, the popular selections lost their interest, while the classical selections gained in interest. Photographs of the subjects taken at the beginning and the end of the experiment clearly showed that they became bored with the jazz and became more interested in the classical music. It is probable that the popular selections produced fatigue on repetition, while the classical selections took on more meaning and thereby became more interesting.

Thus far, this discussion has been concerned with the influence of music upon the listener. There is another problem regarding the effects of music. What is its effect upon the writer and producer of music? There is the popular notion about the artistic temperament. Is there such a thing, and is it common to all artists? We do not know. There seems to be enough evidence to suggest that it is. There is a whole list of performances which go to make up what is meant by the artistic temperament. It is not known how extensive or how common these are among musicians. It does seem likely that both composers and performers are keyed up to a state of high emotionality. These strong emotions may take any form. They may express heights of love, hate, passion, or what are often called the complex emotions. The artist must and does "feel" his parts and feels them strongly. The effects of these strong emotions may be either good or bad. Music has been written and produced by our greatest saints and by our greatest sinners. The lives of some of our great musicians will not stand the light of orthodox moral standards. The Latin and Bohemian quarters of our great cities are generally, to say the least, unorthodox. On the other hand, David, Solomon, Luther, and St. Augustine were composers of note. About the only generalization that can be made is that artists are more emotional, more susceptible to strong actions, either good or bad, either right or wrong, than the common man.

Art

The Beginnings of Art.—In the part of this chapter dealing with art chief emphasis will be placed on drawing, with less attention given to architecture, sculpture, and painting. The same general organization will be followed as in the other parts of the text.

Whether art arose primarily from aesthetic or practical motives we do not know. One author[10] suggests that it was "the occupation of an idle moment." On the other hand, before the invention of writing drawing was used extensively to transmit ideas. Therefore, it is impossible to tell the real sources of art. Probably both motives played a part. Various forms of art were used, as Waddle[11] points out, in representing tribal symbols, in idols, in personal decoration, in the building and decoration of homes, in temples, and in the burial of the dead.

Egyptian Art.—The first development of art of which we have any record was in Egypt. How long ago these earliest examples of art were produced we do not know. The date has been variously estimated as from 3000 or 4000 to even as early as 8000 B.C. Our studies show that art, like music, was well developed before our earliest records. In other words, the real origins of art have been lost.

The records of this earliest period consist largely of temples, tombs, and their furnishings. Of the cities which we know existed at this time we have very few records or relics.

The tombs, variously constructed as sphinxes, pyramids, mastabas, and hypogea or subterranean tombs, were marvels for massiveness and permanence. Although not among the earliest records, the best known of Egyptian art are the Sphinx and the Great Pyramids. The Sphinx is 189 feet long and 70 feet high. The Great Pyramid has a base 756 feet square and is 481 feet high. The temple of Amen at Karnak contained a hall 180 by 330 feet, filled with 134 columns. These columns were as much

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[10] A. F. Chamberlain, *The Child,* Charles Scribner's Sons, 1907.
[11] C. W. Waddle, *An Introduction to Child Psychology,* Houghton Mifflin Co., 1918.

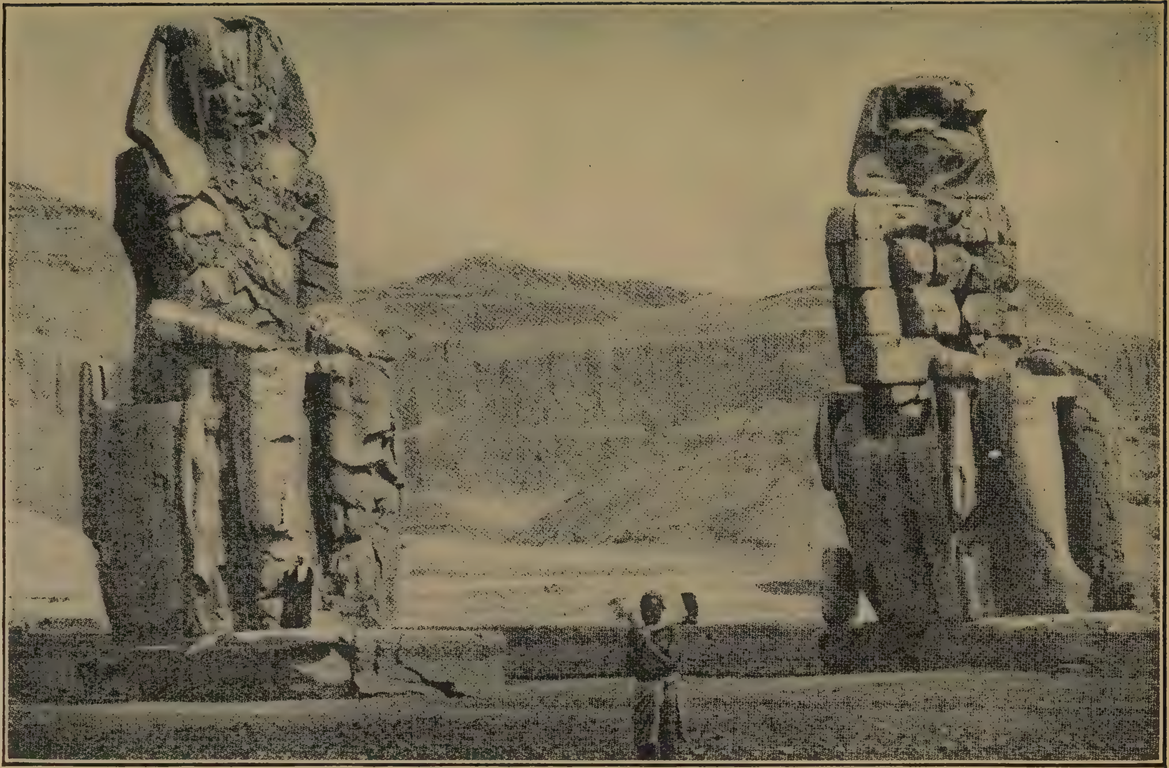

Figure 44. The Colossi of Thebes. Second Theban Era

as 80 feet in height above which rose a roof to the height of 120 feet. How were these huge edifices constructed? Some were of brick, while others were built of huge blocks of limestone or granite. These blocks had to be transported many miles and then lifted into place. How this was done we do not know. Our wonder increases when we are told that such a task would be considered a difficult one with modern methods and implements of engineering.

These tombs were often guarded by lion-shaped figures. In many cases images of the departed were placed near the entrance or at some false entrance of the tomb. Although the real entrance was well concealed, those that have been entered have been found to be filled with all sorts of images, bas-reliefs, and paintings. There was a very definite attempt to make these objects as realistic as possible since the spirit of the dead was supposed to take up residence in his image and be provided for by servants and food from the drawings. This notion of metamorphosis was a distinct factor in favor of the development of art. As a result representations were especially clear. For example, the eyes of the figures were sometimes made of precious stones. Bronze and wood were also used. The stone was sometimes soft, but in some cases so hard that it could not have been cut with ordinary steel.

As compared with later Grecian art, Egypt ranked rather low. However, there was a distinctiveness and faithfulness in its representations which deserves great credit. While there was a directness and realism in the portrayals, there was also a rigidity and lack of originality. The latter fact was due largely to the religious principles which forbade change. There were about fifteen different poses permitted and no others. Therefore, for hundreds of years art in Egypt made little or no progress.

Babylonian and Assyrian Art.—Babylonian and Assyrian art, like that of Egypt, consisted largely of temples and tombs. These peoples also built large cities, such as Babylon and Nineveh, which have long since passed into decay. While the general structure of the tombs was not greatly different from that of the

Egyptians, sculpture and painting were rarer and bas-relief work more common.

It was against the religions of the Egyptians and Assyrians that the Hebrews had such a struggle. Time and again they were led into idolatry. While Moses was on Mount Sinai, Aaron made a molten image of a calf for the chosen people to worship. The Ten Commandments which Moses gave to the people contained the injunction, "Thou shalt not make unto thee any graven image or any likeness of any thing." For this reason the art of the Hebrew was different from that of their neighbors. Furthermore, it was not expressed in lasting materials and hence it is not preserved.

Grecian Art.—Of Grecian art so much is known that little need be said here. How much of it was original and how much was borrowed cannot be accurately determined and is not a matter of great importance. Even if it were borrowed, it was brought to such a state of perfection that credit is due for this alone. The arts in which the Greeks excelled were many. Their temples have never been excelled. In sculpture they were at their best. There are those who claim the same for their drama. While much of real worth in painting was produced, it remained for a later age to perfect this art. However, it is not the purpose of this chapter to more than sketch the beginnings of art; hence we shall pass to the subject of primitive drawing of modern races.

At this point it is easy to show that modern primitive man is not entirely like early man. Primitive man restricts his art largely to the field of personal decoration, painting, and drawing. There are no real illustrations of building on a large scale, unless the work of such peoples as the Aztecs and the Pueblo Indians is included. What sculpture there is takes the form of totem poles and wooden images. Carvings and other types of drawing constitute the chief works of art of modern primitive man.

Most of the studies of primitive art have been made with the American Indian, the Eskimo, and native Australians. The drawings of these tribes bear certain relationships to the drawings of early man. There is often an accuracy of detail that is quite remarkable. Perspective and relative size are almost entirely lacking. The objects represented are those with which primitive man is familiar. Objects predominate over scenery, living objects over lifeless objects. Man and other animals are two of the chief objects delineated. Such art may have some relation to religion but not so directly as with the Egyptians. The only great utilitarian value comes in the form of a picture language. These facts no doubt explain the relative dearth of primitive art of a quality equal to their intelligence.

Children's Drawings.—As in the case of primitive man, drawing is about the only form of art indulged in by children. The meagerness of the forms of art is partly compensated for by its wealth and universality in the one field.

Many studies have been made of the drawings of children. They are principally of two types. One is the study of the drawings of individual children such as that made by Miss Shinn on her niece and by the Sterns with their children. The other is of the questionnaire type, stimulated largely by the work of G. Stanley Hall.

Hall and his students have analyzed thousands of children's drawings. On the basis of such studies Lukens outlined the following stages in children's drawings: (1) The scribble age, extending to age 4 or 5. (2) Artistic illusion age (6 to 10 years), in which considerable originality and some ability are shown. Gross inaccuracies and misrepresentations occur, yet some features of real merit appear. (3) The self-conscious period (10 to 14 years), in which the child becomes critical of his own work and is likely to stop drawing. (4) The period of rebirth during early adolescence, in which the child who draws does so with interest and seriousness of purpose. These periods are to be looked upon as suggestive, and there is certainly no clear line of demarcation between one period and another.

What Children Draw.—Studies have also been made[12] of what sorts of things children draw. Stella McCarty analyzed 31,239 drawings of kindergarten, first, and second grade children. She found that younger children, like primitive man, draw human and animal forms. Then come natural objects, houses, flowers, and simple scenes. As children grow older, wider and more abstract interests develop. There are not many sex differences. Boys draw objects representing a larger range of adult social interests. Girls draw objects relating to childhood itself.

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[12] For the earlier studies see H. T. Lukens, "Children's Drawings in the Early Years," *Pedagogical Seminary and Journal of Genetic Psychology,* Vol. 4, pp. 79–110, and E. Barnes *et al., Studies in Education,* Vol. 2, p. 102ff.

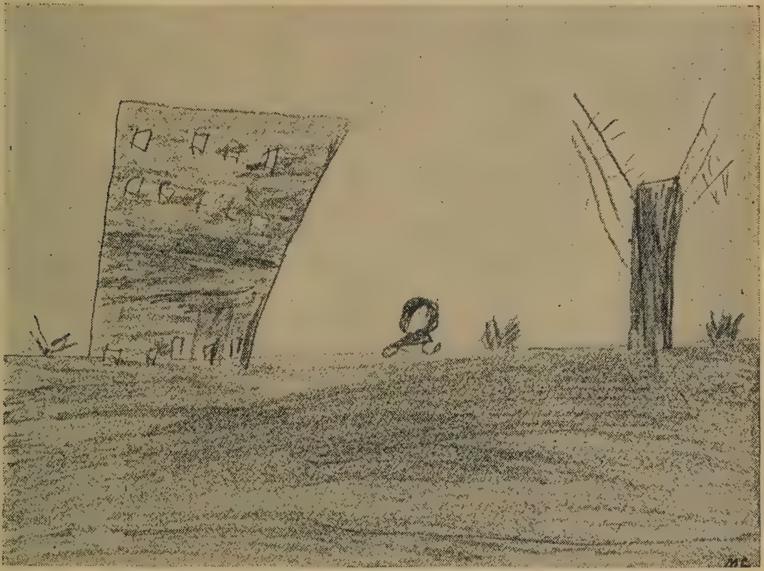

Figure 45. Sample Drawing by a 6-Year-Old Child

As stated above, the drawing of persons is very common with children. Such figures almost always have a head drawn front view with eyes, nose, and mouth outlined. There may be little or no neck, but arms and legs are generally drawn. Relative size of parts of the body is commonly distorted. Later, side view pictures are drawn. Sometimes there is an attempt to show two eyes. Other difficulties are met in various ways. The child tends to draw from memory rather than from direct observation. The child, for example, will draw a square for the top of a table even though he is looking at the table from some oblique angle.

Although, as a group, the more intelligent children draw better than slower children, there are many exceptions to this rule; that is, there is not a very high correlation between drawing and other kinds of ability. The disagreement is so great that drawing, like music, is often considered to be a special ability.

Drawing Scales.—In order to evaluate drawing, Thorndike has constructed a scale for measuring drawing. The items of the scale were arranged by the order of merit method. By comparing a sample drawing with this scale grades may be assigned and comparisons made between drawings. The scale is admittedly imperfect, and its usefulness is limited. However, it is about the only method we have for such evaluation other than a purely subjective judgment of the teacher.

Studies in the Genesis of Children's Art.—Norman C. Meier[13] and his students are engaged in an extensive study of the genesis of art in children. Already studies have been completed on the problems of balance, stability, symmetry, color harmony, and rhythm, as factors in art.

In the first study children were asked to reproduce one or the other of two designs in colored blocks. One sample presented good illustrations of balance, stability, and symmetry; the other did not. Even by 2 years of age children prefer balance to lack of balance, but correlation with age and intelligence is low (0 to .20). Color harmony was tested by the ability to select appropriate scarfs to match dressed dolls. Such ability does not emerge before about the fourth year. Rhythm was studied by the ability to select the appropriate figure to complete a sequence. For example, a colored panel showing rabbits running across a field of rising and falling slopes has one place left blank. From four possibilities the child is to select the appropriate figure to complete the sequence.

Other studies are in progress to determine how much of the difference in abilities in children is to be explained on the basis of the environment of the child, and how much must be explained on other grounds. When these studies are completed we shall know much more about the genesis of drawing ability in young children.

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[13] The following information was obtained by correspondence between the author and Dr. Meier. As yet these studies have not been published.

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CHAPTER 12

THE GROWTH OF INTELLIGENCE

What Is Intelligence?—Psychologists are not agreed upon the definition of intelligence. One of the chief differences of opinion is whether it is entirely a matter of inheritance or whether intelligence is modified by training. It is not the purpose of this text to enter into a discussion of this question. Suffice it to say that, at least it is impossible to separate the innate and acquired factors and no attempt will be made here to do so.

The Evolution of Intelligence.—There are other important problems in the definition of intelligence. One of these is its genesis. If we accept one of the common definitions of intelligence as the ability to meet and solve novel situations, then we must admit that the lower animals possess a certain amount of intelligence. Indeed, the process of evolution is a process of growth of intelligence from the lowliest forms of life to man. As yet we have no exact means of comparing the intelligence of one animal with another. It is impossible even to compare maze learning in animals, since the degree of adaptability to certain designs and sizes of mazes seems to vary widely from one animal group to another. The results of comparing learning on one type of maze—as, for example, the Hampton Court maze for white rats—with another type, for instance, pencil mazes for man, are open to even more criticism.

One other method of comparing the intelligence of different species of animals is by means of the delayed response, that is, the maximum time that may elapse between the stimulus and the response. For example, the delay between the presentation of the stimulus and the response in the white rat cannot be more than about five seconds, for cats it can reach 18, with dogs it may be increased to from one to three minutes. But this method has its limitations. We can also use the method of general comparisons. For example, while a cat and a rat do not perform the same kinds of acts, it is reasonably certain that the cat is more versatile and, in general, more intelligent than the rat.

Using any or all these methods we might compare the different species and subspecies of animals listed in Chapters 2 and 3. In fact, the survey of the studies of these different animals gives some such classification except that it is not expressed in quantitative form. The paramecium is more intelligent than the amoeba. It is more versatile and more adaptable. Likewise the earthworm is more intelligent than either. And while the bee cannot do many of the things that the earthworm does, it can meet the problems of life more efficiently than the earthworm can meet its problems.

Evolution means just this. Each higher form has developed some new and better mode of meeting problems of life. This may consist in living in some other place. For example, the new species may develop wings and take to the air or it may grow a new type of jaw or digestive system enabling it to eat a different kind of food. In so doing the animal may lose some capacity it has possessed. For example, in taking to the air it may lose its usual methods of constructing a home and suffer because of this. It may also specialize in a certain direction and thereby doom itself to destruction. The dinosaur's specialization in size eventually made it a prey to smaller, more agile, animals.

This shows that not all change means progress. Some changes may be actually harmful, sometimes it may be temporarily advantageous and eventually disadvantageous. Nevertheless, in general, change forms the basis upon which progress is possible. The history of evolution is the story of these changes and on the whole they have meant progress. Man considers himself the last major evolutionary product and likewise the most intelligent of the animals.

In Chapter 5 the problem of the intelligence of prehistoric man was raised. It will be recalled that Osborn considered Cro-Magnon man as almost if not as intelligent as modern man. This would be difficult either to prove or disprove. The problem of intelligence in man presents a further difficulty than that in other animals. Animals do not change their habits of living from one generation to another as man does. For example, birds build their nests much the same as they did as far back as records exist. Man has changed his methods of home building in many ways.

Man's increasing ability to cope with the problems of his environment might be explained in several ways. In contrast to other animals man may grow progressively more intelligent from generation to generation. This may or may not be true. It would be hard to discover whether this is true or not. Another possible explanation is that man has not become more intelligent but, because of his ability to construct and use language, each generation conserves the heritage of all former generations. Through this heritage in the first few years of life the child is able to learn what has been accomplished by his ancestors and upon this basis he is able to progress to new heights of accomplishment. There is no doubt about the truth of this latter explanation. The one question is whether it is the only explanation of man's progress.

Either of two experiments might answer this question. If several members of some prehistoric race of man could be introduced to modern society it would not be difficult to find whether they had sufficient intelligence to cope with the new environment as successfully as modern man. Or if a number of some modern intelligent race should completely lose their heritage of the past and be completely isolated from other men, would they show any more intelligence in coping with their problems than did early man? Of course, in each experiment the members concerned in the experiment would necessarily begin the experiment at birth. Manifestly neither of these experiments has been carried out. There are a few stories mostly of the Romulus-Remus or Sunday Supplement variety and others of a somewhat higher degree of probability of children who have been brought up by wild animals. Even if one of these stories proved to be true little could be proved from it as it would take several cases with considerable assurance that they were normal infants to prove the case one way or another. In the absence of such proof one guess as to the explanation of man's progress is about as good as another.

The history of civilization has been an account of the rise and fall of various civilizations. The first historic accounts concern Assyria, Egypt, and China. These civilizations flourished for a time and in the case of the first two were almost completely lost, to be superseded by the Hebrews and Babylonians. Later Greece became the center of the civilized world, to be followed by Rome. Is this the story of the rise of men with superior native endowment, or is it the story of special advantages, or is it both? Until further evidence is submitted, each of us may hold his own particular view on the subject.

There is, of course, the related but not so impossible problem of the modern so-called backward races. Are they backward because of some inherent lack of ability, or for some reason have they been denied the advantages of the progressive races? There are many instances of modern backward races being introduced into modern civilized society. The results of such transfers vary. In some cases, as in the case of the Japanese, the adaptation is almost complete. In others, as in the case of the negroes and Indians, it has met with success in some cases and failure in other cases.

Racial Differences in Intelligence.—There is little question that there are racial differences in capacity. While none of the studies of these differences has been entirely satisfactory, it must be recognized that real differences appear. National differences between members of the same race also appear, but are probably not so marked. The following table shows the rela-

TABLE 4. COMPARISON OF PERCENTAGES OF HIGH AND LOW SCORES ON ARMY ALPHA BETWEEN NATIVE AND FOREIGN BORN IN THE U. S. ARMY

Native Country	% A and B, High Scores	% D, D–, and E, Low Scores
United States (white)	12.1	24.1
England	19.7	8.7
Canada	10.5	19.5
Germany	8.3	15.0
Sweden	4.3	19.4
Ireland	4.1	39.4
Turkey	3.4	42.0
Russia	2.7	60.4
Greece	2.1	43.6
Italy	0.8	63.4

tive percentages of men making high and low scores on Army Alpha, the mental test used upon 1,750,000 American troops during the World War, when classified by nationality.

The reader can think of many reasons why these are not fair measures of the intelligence of the races represented. The selection of the army was not representative. The tests used, even Army Beta which was used with illiterates, were not a fair measure of intelligence. However, the races from northern Europe with an equal language handicap made much higher scores than those from southern Europe. This seems to lend support to what is sometimes spoken of as Nordic superiority. As an answer to this, it has been suggested that, if so inclined, some race such as the Chinese might construct a test based upon their civilization which would show the Nordic races in an inferior light. On some such grounds Boaz has contended that each race is best fitted for the position which it holds and that arguments about racial superiority are futile. Such a statement seems to be the other extreme from the contention for Nordic superiority, and it is probable that the truth lies somewhere between these extremes—that some but not too great a degree of importance is to be attached to racial differences in intelligence.

The wealth of discussion and dearth of agreement on all such questions indicates how little we really know about how intelligence evolved, either in the animal series or in early or modern man. Concerning the growth of intelligence in the individual, however, though much remains to be learned, relatively much more information is available.

The Growth of Intelligence in the Individual.—The child at birth is endowed with certain innate forms of response. These meet most of the purely vegetative needs of the child, but they are not sufficient to enable him to continue to live and get along without assistance. While the child may have the equipment for taking and digesting food and eliminating waste products, he is not prepared to seek or secure food; it must be brought to him. Neither is he protected or able to protect himself from cold and heat. There is a long list of things which the parent or nurse must do in order to keep the young infant alive. But as the child grows older, the ministrations of parents and others become fewer and finally largely cease. The child must gradually learn to make new adjustments in order to meet the problems of life. As was pointed out in the preceding chapter, this very incapacity in early life to meet and solve problems is inversely proportional to the individual's capacity to *learn how* to make these adjustments later. The fewer the fixed responses of the organism, the wider and more numerous the modifications which may take place.

The ability to make successful adjustments to life situations we may call intelligence.[1] At least four different features or elements are involved: (1) the innate capacities of the individual present at birth or evolving during life as a result of maturation rather than experience, (2) the *motivation* to make new adjustments, i.e., to learn, (3) the capacity to make new adjustments and to remember those that have been made, and (4) the effect of the environment in which the individual is placed upon this capacity.

In this list of elements in intelligence two factors are indissolubly bound together. One is heredity and the other environment. In the list just given, numbers 1 and 3 and part of 2 are inherited. The remainder of 2 and 4 are environmental. We shall take up in more detail what is meant by each.

The Innate Basis for Learning.—McDougall[2] is probably right when he says that all people are endowed with about the same reflexes and instincts. We do not vary so much in the number of these as we do in their relative strength. While the capacity is generally present, some children are born with a greater tendency to fear or anger than others. Some have better sense organs, some have better physical constitutions, and others have better digestions. Body form and structure and especially structure of the nervous system to be discussed a little later are factors. These hereditary foundations have a large influence on the learning which is built upon them.

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[1] Terman defined intelligence as the capacity for abstract thinking. William Stern defined it as the capacity to meet and solve novel situations. Colvin gave as his definition the capacity to learn. Thorndike considered it as the sum total of specific abilities. Other definitions are to be found in F. N. Freeman, *Mental Tests,* Houghton Mifflin Co., 1926, Ch. XVIII.

[2] Wm. McDougall, *An Introduction to Social Psychology,* J. W. Luce & Co., 1927.

Motivation as a factor in intelligence has already been discussed in Chapter 9 under the head of learning. McDougall has listed the ways in which original nature is modified: (1) by pain and pleasure, (2) by rewards and punishments, (3) by social praise and blame, and (4) by ideals. Jordan[3] has more recently listed the chief forms of motivation in education as: (1) mental set or attitude, (2) praise or reproof, (3) rivalry between groups, (4) rivalry with one's own past record, and (5) interest.

The third factor in intelligence is the capacity to learn. This is an inherited capacity. While its expression depends upon the environment, the ability of the individual to adapt to the environment is also a factor. There are, no doubt, several elements involved in this capacity. It is essentially a characteristic of the nervous system although the whole organism is involved. Any sensory defect reduces the capacity to adapt. Any motor defects also limit adaptation. No neurological study has yet discovered just what differences exist between the nervous systems of the superior and the inferior individual. Only in the exceptionally low grade persons do any apparent gross or microscopic defects exist. While the bases for these defects or advantages cannot be discovered by our present techniques, practical results prove that such differences exist. We may some time discover that these differences depend upon the number of neural connections, the permeability of these connections, the character of neural substance, a combination of some of these, or some other element or elements in the nervous system. Whatever the source, differences exist.

Individual Differences in Intelligence.—How great these differences are we can only guess. Terman has found the following distribution of I.Q.'s for 905 unselected school children from 5 to 14 years of age. Other studies have shown a range of I.Q.'s from near zero to something over 200. There is no method for determining in terms of absolute units just how much more ability one person has than another. An I.Q. of 140 means more than twice as much intelligence as an I.Q. of 70, but we cannot measure how much more. Daniel Starch[4] has estimated that, on the average, the best pupil in a given class or grade is able to do from two to twenty-five times as much work as the poorest pupil; or, stating the same fact in another way, he is able to do the same task from two to twenty-five times as well. This, of course, is only a guess but probably a very good one.

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[3] A. M. Jordan, *Educational Psychology,* Henry Holt & Co., 1928, Ch. IV.

Sometimes this capacity to learn has been assumed to be the only factor in intelligence. If any writer wishes to mean that intelligence is this and nothing more, there is no reason for denying him this privilege. However, as stated earlier, it seems better to assume that, since the capacity can never exist apart from the environment, it is better to look upon intelligence as a measure of present attainment rather than capacity alone. It is only when capacity exists that attainment is possible, but capacity alone is not possible.

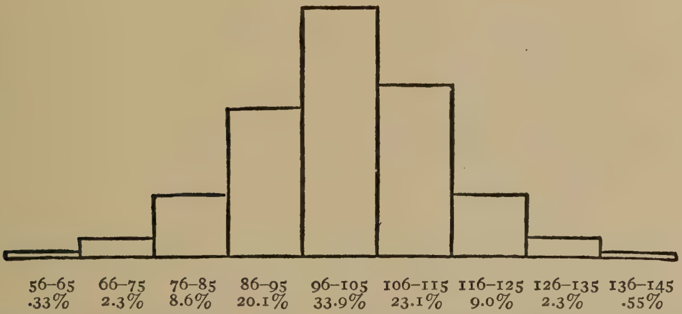

Figure 46. Distribution of I.Q.'s of 905 Unselected Children, 5–14 Years of Age

(L. M. Terman, *The Measurement of Intelligence,* Houghton Mifflin Co., 1916)

Many writers in discussing intelligence test scores realize that different environments at least affect intelligence scores. Terman, who emphasizes the innate character of intelligence, says that we should allow a difference of ten points in I.Q. between children from the lower and the higher social strata of society. Yerkes and Bridges give different norms for different social groups. The extremes are several points apart for each age.

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[4] Daniel Starch, *Educational Psychology* (rev. ed.), The Macmillan Co., 1927, p. 28.

Effect of Social Status upon Intelligence Test Scores.—Freeman[5] has made the most exhaustive study of the effects of changes in social status upon mental test scores. A group of 401 foster children were tested both before and after placement in foster homes. There was a marked improvement in the mental test scores after placement. This gain was sometimes equivalent to as much as 15 to 20 points in terms of I.Q. after the child had remained in the foster home for four years or more. When the scores were corrected for inconsistencies in the tests, the children placed in good foster homes gained, on the average, about 10 points; while those placed in poorer homes made an average gain of 5 points.

The correlation between siblings, after they had been reared apart in foster homes, was .25. This is only half the correlation generally found between siblings reared in the same home. Living apart increases their difference. On the other hand, while we might not expect to find any correlation between unrelated children when they have been reared in the same home, the correlations ranged from .25 to .37.

The available information indicated that most of these foster children were born of feebleminded parents. However, only 3.7% of the foster children had an I.Q. below 70. In 26 cases both of the parents were rated as feebleminded, but only 4 of the children were below 70. The average I.Q. of the children placed in good homes was 95 and of those placed in poor homes, 86. There is considerable evidence that there was little or no selection of children into better foster homes on the basis of intelligence.

Although the foster children had I.Q.'s slightly below that of the average school population, these children did average school work.

Most of these children had parents who were morally defective. In spite of their poor heredity there were very few cases of serious misdemeanor in the group.

A somewhat similar study by Barbara Stoddard Burks in California showed slightly less effect of environmental influences, probably because only native-born white children were used in her study.

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[5] F. N. Freeman, *The Twenty-seventh Yearbook for the Study of Education*, pp. 103–219.

Rate of Mental Growth.—Let us now study the problem of the rate of mental growth. Four main problems arise in this connection: (1) Where does intelligence begin, that is, what is the zero point in mental growth? (2) How rapid is its development (including the form of the growth curve)? (3) What differences, if any, exist in the rate of mental growth? and (4) What constitutes mental maturity?

The first question is largely one of theoretical interest. In any problem of measurement one of the elements is the zero point. This point is generally assumed to be at birth. This is not far from correct. It is true that some adjustments are made immediately at birth. This might lead us to place the zero point somewhere before birth.

The normal rate of mental growth has received considerable attention. Yet any of the methods now in use fail to give us a means for measuring mental growth except in terms of comparison.[6] Since the first work of Binet, we have been able to measure mental growth in terms of accomplishment. For example, we have been able to say that a certain 4-year-old child could not do more than the average 3-year-old.

More recently this relation has been expressed in terms of the I.Q. In the I.Q. we have made the assumption that growth is proportional, that is, one year's retardation between 3 and 4 years of age is the same as two years' retardation between 6 and 8, or three years between 12 and 16. There is considerable evidence to justify this assumption. However, two different assumptions have been made. Terman, as well as most other workers, believes that mental growth takes the form of the typical learning curve;[7] that is, it is rapid at first and then becomes negatively accelerated. Many tests of mental functions give evidence to support this view.

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[6] An ingenious attempt at such measurement is presented by Thurstone and Ackerson, *Journal of Educational Psychology*, (1929) Vol. XXX, pp. 569–583. Possibly the above statement should be revised in the light of this study.

[7] F. N. Freeman ("The Interpretation and Application of the Intelligence Quotient," *Journal of Educational Psychology*, Vol. XII, 1921, pp. 3–13) has suggested that the mental growth curve may be a straight line. He cites many cases where progress from year to year on some types of tests gives a straight line. If this be true, either progress continues at the same general rate from birth to death or progress suddenly ceases at some age without gain thereafter. It seems more likely that mental progress does not follow a straight line but a negatively accelerated one. Possibly Freeman's cases are those in which the studies began too late or did not continue long enough to show negative acceleration.

Do all persons increase in intelligence at the same rate? To this question there is a very definite answer. Intelligence differences have always been recognized. In early times in the selection of a tribal chieftain certain intellectual as well as physical capacities were considered. This developed into the practice of kings and absolute monarchs. Whether deliberately or accidentally established, this doctrine was connected with the idea that capacity was inherited. The result was the establishment of royal families. This idea was generally practiced up to and during the Middle Ages in both state and church.

Because of the evils of special classes in church and state, the French Revolution had equality as one of its three mottoes. The resulting consequences was a tendency to minimize differences. Thomas Jefferson, a close student of French thought, wrote into our own constitution the statement that "all men are created equal." While the emphasis was especially upon political equality, popular opinion has more or less considered it to apply to all forms of equality. Of course, physical inequality is apparent, but mental differences have tended to be minimized.

The writer has discovered that the average student in evening courses in psychology—probably a fair cross-section of the generally well-educated group—will admit that there are differences in ability, but believes that they are no greater than physical differences, if as great. Even the typical undergraduate college student does not believe the differences to be as great as that mentioned by Starch.

While mental tests have not answered the question of how much these differences are in terms of multiples or any objective unit, they have given an answer in terms of years of retardation or acceleration. It is important to measure it in terms of years of retardation or acceleration. We may find that a child is two or three years retarded or accelerated at the age of 6. This has great significance in determining where to place the child in school and in knowing what to expect of him in moral or social responsibility.

The story of mental growth has been told in biography, history, literature, and song. From Homer's account of his heroes in the *Odyssey* and the *Iliad,* and Virgil's story of Aeneas, down to the character in the latest best seller, we have had presented pictures of mental growth. While most of these accounts have told the story of unusual people, others, such as the more recent work representing the new realistic school in literature, have given a characterization of a typical person with normal interests and abilities.

Studies of the Intelligence of Infants.—Most of these accounts start with the character several years of age, or at least spend little time upon the early years. Rousseau, in contrast with these, spent much time upon the youth of his character, Émile. But he emphasized one phase in Émile's life—his education. Preyer[8] was the first man to make an exhaustive study of the early life of a child. Preyer traced the growth of sensory capacities of his children for the first three and a half years of their lives. He also studied their reflex and instinctive tendencies. Preyer's study has formed a model for most later similar studies. There are many other studies, some of which have already been mentioned in other connections in this text. The one which has received most attention in recent years is that by Millicent Shinn.[9] Miss Shinn made a careful study of her niece for the first year after birth. This account is not so successful for its psychological insight as for its clever description and pleasing style. She describes in detail the activities of the child from the earliest breathing and grasping reflexes through the development of her senses to learning to talk and make the other ordinary adjustments of this period of life.

For several years Gesell[10] has studied children under semi-controlled conditions in the Yale Psycho-Clinic. He has devised clinic nursery rooms with hidden observation booths for the study of infant behavior. Upon the basis of his studies, Gesell gives norms of development for each month of the first two years of life. These are more reliable and representative than those mentioned by Shinn because the baby studied by Shinn was probably a superior child, the conditions under which the observations were made were uncontrolled, and there was only a single case. On the other hand, Gesell studied, presumably, average children under controlled conditions on 195 specific behavior items. Fifty infants were used in standardizing the test norms.

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[8] Wm. Preyer, *The Mind of the Child,* D. Appleton & Co., 1888.

[9] M. W. Shinn, *The Biography of a Baby,* Houghton Mifflin Co., 1900.

[10] Arnold Gesell, *Infancy and Human Growth,* The Macmillan Co., 1928.

Many other studies, beginning with the work of Binet, have attempted to determine standard behavior for different age levels. We need mention only a few of the better-known of these: the Kuhlmann and the Merrill-Palmer for the kindergarten age and below; the Stanford revision of the Binet for 3 years and above. The Pintner-Paterson Performance tests and a long list of group tests might also be mentioned. The individual tests upon the basis of extensive experimentation have chosen sample performances of normal children for the various years. They, therefore, give us a cross-section of what a child of any age should be able to do.

AGE 6

1. Distinguishes Morning and Afternoon.
2. Defines Words in Terms of Use.
3. Copies a Diamond.
4. Counts 13 Coins.
5. Esthetic Comparison.

AGE 7

1. Knows Right and Left.
2. Description of Pictures.
3. Executes Three Commissions.
4. Gives Value of 3 Single and 3 Double Sous.
5. Names Four Colors.

AGE 8

1. Comparison of Two Objects. Differences.
2. Counts Backwards from 20 to 0.
3. Unfinished Pictures.
4. Knows Date.
5. Repetition of Five Digits.

AGE 9

1. Makes Change.
2. Definitions Superior to Use.
3. Knows Value of 9 Pieces of Money.
4. Repeats the Months of the Year.
5. Comprehension of Easy Common-Sense Questions.

AGE 10

1. Arranges Five Boxes in Order of Weight.
2. Copies Two Designs from Memory.
3. Criticizes Absurd Statements.
4. Comprehension of Difficult Common-Sense Questions.
5. Uses Three Words in Two Sentences.

AGE 12

1. Resists Suggestion (length of lines).
2. Uses Three Words in One Sentence.
3. Names Sixty Words in Three Minutes.
4. Defines Abstract Words.
5. Disarranged Words Arranged into a Sentence.

AGE 15

1. Repetition of Seven Digits.
2. Finds Three Rhymes for a Given Word.
3. Repetition of a Sentence of 26 Syllables.
4. Interprets Pictures.
5. Explains Problem Questions.

ADULT

1. Paper Cutting.
2. Reversed Triangle.
3. Three Differences between a President and a King.
4. Differences between Pairs of Abstract Terms.
5. Gives Sense of a Passage from Hervieu.

Figure 47. Sample Questions from the Binet Intelligence Test

Not only have normal children been studied, but both superior and inferior children have been studied. Terman[11] studied nearly 1,000 gifted children with I.Q.'s of 130 and above.

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[11] L. M. Terman *et al.*, *Genetic Studies of Genius*, Stanford University Press, 1925, Vol. I.

These he compared with a group of normal children of similar ages. Both boys and girls were included in the study. The following brief summary will give some idea of the chief differences between the bright child and the average child.

Differences Between Superior and Average Children.—

1. Anthropometric Measurements. The gifted group were above the most reliable norms for weight and height. A large proportion have broad shoulders and hips, strong muscles, and well-developed lungs. While the gifted are above the norms, only 62% to 73% deviate more than 10% above or below these norms.

2. Health and Physical History. The mean birth weight of the gifted group was approximately three-fourths of a pound above the norm according to accepted standards. The age of learning to walk averaged about one month less and of learning to talk about three and a half months less than the mean ages for normal children. In contagious disease history they show no significant differences. Nearly 30% were reported less frequently as having symptoms of "general weakness." Of the control group 16.1% were reported as nervous and only 13.3% of the gifted group were so reported. Pubescence seems to occur earlier with the gifted children, although the data are not conclusive on this point because of the limited number of children of pubescent age in the study. In summary, the gifted group is superior to the control group in health.

3. Educational History. According to the usual standards, about 85% of the gifted children are accelerated and not one is retarded. Approximately 85% have skipped one or more half grades as compared with 4% who have repeated. The mean net gain from skipping is one full grade. Their attitude toward school work is decidedly more favorable than that of the control group. The inclinations of superior intelligences most often noted were quick understanding, insatiable curiosity, extensive information, retentive memory, early speech, unusual vocabulary, etc. Terman says, "Although the home environment of the gifted children has been, on the whole, above the

average, nothing has been found to warrant the belief that the superior intellectual attainments of our gifted group are in any considerable degree the product of artificial stimulation or forced culture."

4. Play Interests. The gifted children show measurably greater interest than the control group in activities that require thinking and that are mildly social and quiet. They show slightly less preference than do the control group for competitive games. There was less difference in the sex preference in playmates. They tend to enjoy playing with children older than themselves. The gifted children read much more than the average children. They read more widely distributed topics and on topics of more scientific nature.

5. Intellectual, Social, and Activity Interests. By means of tests constructed by Mrs. Wyman, the gifted group was compared with the control group in intellectual, social, and activity interests. The results of these tests are shown in the accompanying graphs. From them it is apparent that the gifted group are significantly above the control group in intellectual and social interests and about the same in activity interests for all ages.

6. Character and Personality Traits. On a battery of seven tests, five constructed by Raubenheimer and two by Cady, the gifted children did consistently better than the control group. Sixty to 80% of the gifted children equaled or excelled the mean of the control group in total score on the tests.

7. Trait Ratings. By means of a graphic rating scale the gifted group was compared with the control group on 31 traits. The ratings were made by teachers. Of course, these ratings were subject to all the difficulties and errors of ratings in general. Chief among these difficulties probably was the halo effect, whereby a person who is high in one trait is likely to be rated high in all traits. In (1) health, the gifted group was rated slightly higher than the control; in (2) physical energy, they were significantly higher; in (3) prudence and forethought, they were considerably higher; in (4) self-confidence and (5) will and

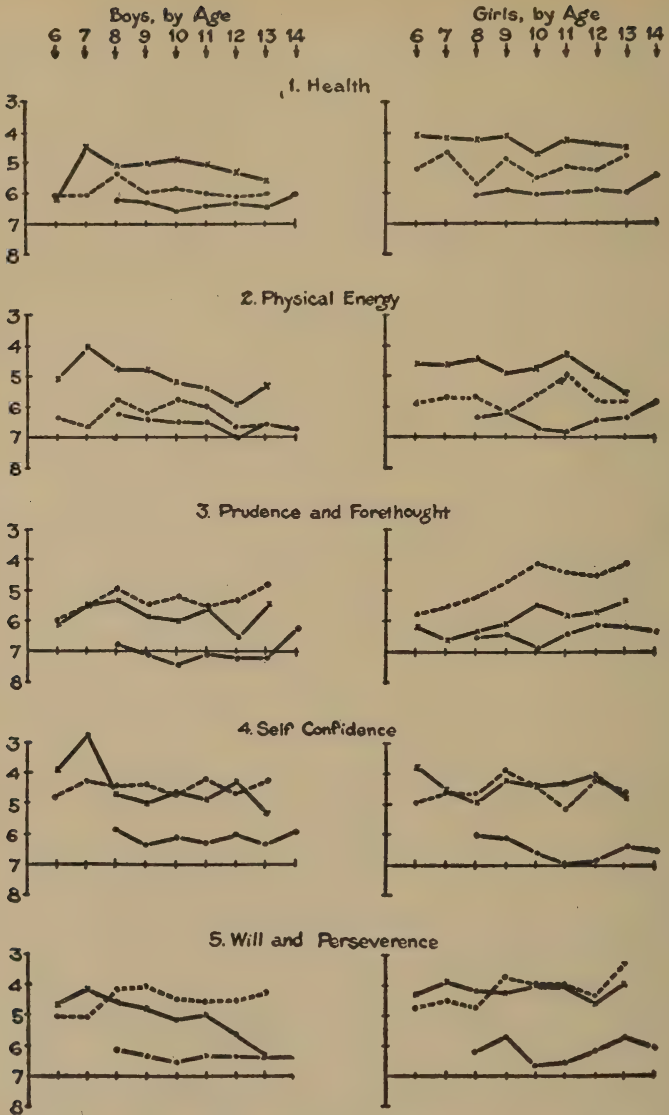

Figure 48. Trait Ratings on Five Traits for Superior Children

Ratings by parents x—x—x; teachers .... The solid line is for a normal group of children, made by the teachers. In all ratings 1 is high and 13 is the lowest possible rating.

(L. M. Terman, *Genetic Studies of Genius,* Stanford University Press, 1925) perseverance, they were likewise higher; in (6) musical appreciation and (7) appreciation of beauty, they were only slightly superior; in (8) sense of humor, (9) cheerfulness and optimism, and (10) permanency of moods, they were superior but there was slight difference; in (11) fondness for large groups there was slight difference; in (12) leadership, (13) popularity, and (14) sensitiveness to approval or disapproval, there was little difference; in (15) desire to excel, the gifted were significantly higher; in (16) freedom from vanity or egotism, (17) sympathy and tenderness, and (18) generosity and unselfishness, there was little difference. There were decided differences in (19) conscientiousness and (20) truthfulness, the gifted children being much superior. In (21) mechanical ingenuity there was seemingly no difference, but the boys in both groups, as might be expected, were considerably higher than the girls; in (22) desire to know, (23) originality, (24) common sense, and (25) general intelligence, the greatest differences were shown. The ratings on the first five traits are shown graphically in the accompanying figure. This report is given in some detail since it gives a good picture of the traits or capacities in which the superior child differs markedly from the average.

Studies of Inferior Children.—A sequel to Terman's study is furnished by Mrs. Woolley.[12] She compared a group of children who remained in school with a group of the same age who withdrew from school and began to work. The two groups were as nearly equal as she could get in scholastic standing, but those remaining in school were superior because no correspondingly high groups withdrew. There were 1,500 children in the original study, but only 663 were available for the four-year comparison from 14 to 18 years of age. This number was tested and given physical measurements each year for the period. The results of the comparison is just the opposite of that found in the superior children.

The children who withdrew from school were inferior in physical measurement throughout the comparison. However, there was a greater difference at 14 than at 18. At 14 one-fifth of the working group equaled or exceeded the school group; at 18 one-fourth of the boys equaled or exceeded, and four-tenths of the girls equaled or exceeded the school group. The children who withdrew from school were inferior in dexterity tests. Only in one test, steadiness, did the working group eventually exceed the school group. In strength and vital capacity the school group became increasingly superior. In mental tests the school group was superior throughout and became increasingly superior from year to year. This superiority extended also to the economic and social status of the school group.

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[12] H. T. Woolley, *An Experimental Study of Children at Work and in School Between the Ages of 14 and 18 Years,* The Macmillan Co., 1926.

These two studies give a good general comparison of superior and inferior children and normal children. These differences extend not only to mental and educational accomplishment but to physical and social achievements as well.

We are further concerned with the way in which intelligence develops in the retarded or accelerated person as compared with the normal. Kuhlmann and others believe that the mentally retarded stop developing at an earlier chronological age than the normal, and that the superior child continues to grow mentally longer than the normal.

Freeman,[13] on the other hand, summarizes some experimental evidence to show that mental maturity is reached at about the same chronological age irrespective of ability.

Mental Maturity.—It is probable that the point of maturity varies for different individuals. This may not bear any relation to the ability of the person; that is, there are individual differences in the age of maturation. These differences are probably as great as the differences in rate of mental growth. If such be true, we cannot predict the final attainment of any person by measuring his I.Q. during childhood. Some children develop rapidly but reach maturity early; others develop more slowly but continue growth for a long time. This accords with physical growth. The author has also accumulated some experimental evidence by repeated tests on the same individual throughout later adolescence which seems to bear out this contention.

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[13] Freeman, *Mental Tests*, pp. 347–348.

What Is Average Intelligence?—The last major problem is the normal attainment of the average adult at maturity. The answer to this question presents some difficulties similar to those encountered in the other questions. How may we measure this attainment? There are three ways in which this may be done, but each has its limitations. We may determine standard performances for the adults on tests or we may compare adults with the accomplishments of children. How much more can adults do than children, if anything? Brigham[14] compared the scores made by 1,750,000 men in the U. S. Army during the World War with scores made by school children. It was assumed that the men in the army represented a fair sampling of average adult intelligence.

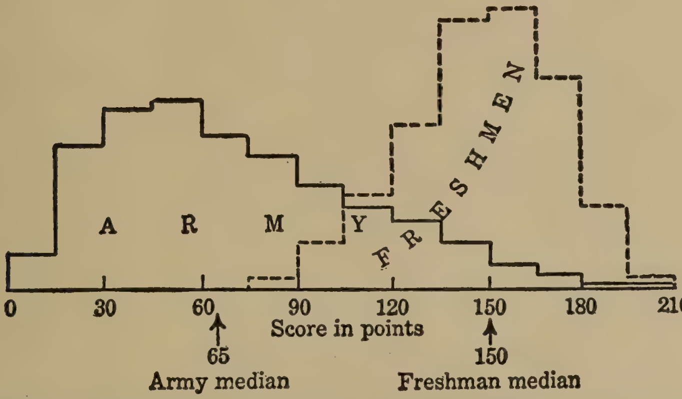

Figure 49. Distribution of the Scores of Drafted Men, and also of College Freshmen, in the Alpha Test

The height of the broken line above the base line is made proportional to the per cent of the group that made the score indicated just below along the base line.

(R. S. Woodworth, *Psychology*, Henry Holt & Co., 1929)

The army average was equal to that made by 13-year-old children. Since most of the college men were either already in Europe or in preferred groups and therefore were not included in the groups tested, it has been claimed that 14 years would be nearer the average for the American public than 13. But to say that the average adult has the intelligence of a 14-year-old is paradoxical at least. It only means that the army average was near that of a selected group of public school pupils in California.

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[14] C. C. Brigham, *Study of American Intelligence*, Princeton University Press, 1923.

In terms of the Stanford revision of the Binet tests, the average adult can define 65 words from the standard list of 100. He can interpret certain fables; differentiate between laziness and idleness, evolution and revolution, poverty and misery, character and reputation; repeat six digits backward; and perform other similarly difficult tasks.

In social relations he can get along with his fellows in a way. He can earn a living under ordinary circumstances, rear a family, and be a respectable citizen.

Like the differences in rate of growth, there are many differences in ability of adults. Some have contributed much to the world's good, economic, social, ethical, artistic, or intellectual. Others have not the ability to care for their own personal needs. Between these extremes most of us are to be found.

The closing problem for the chapter is that of when senescence begins and its extent. With the many studies of the intelligence of children and young people there have been relatively few studies of middle-aged people and fewer still of old age. Most of the studies that have been made in this field were rather incidental studies of various vocational groups. For example, one of these studies was made with a large group of medical doctors.

Recently an extended study has been made by Walter R. and Catherine Miles[15] of the population of two good-sized cities. A special fifteen-minute form of the Otis Higher Examination was given to 823 people ranging from childhood to about 90 years of age. There was a good distribution in each age group with not less than 60 in each decade between 50 and 80 years inclusive. The following figure has been constructed largely from the Miles' data. This seems to show a consistent decline in intelligence beginning between 40 and 50 and becoming progressively greater for the higher ages. These results seem to be supported by the other studies, such as that by Grace,[16] so far as they include groups of the higher ages.

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[15] C. C. and W. R. Miles, "The Correlation of Intelligence Scores and Chronological Age from Early to Late Maturity," *American Journal of Psychology,* (January, 1932) Vol. XLIV, pp. 44–78.

[16] A. E. Grace, *Adult Educational Bulletin,* No. 94, Cleveland Board of Education, 1930.

It is not in general agreement with Thorndike's[17] results in learning ability in that the rate of decline is more rapid than that found by Thorndike. It may be true that intelligence as such declines more rapidly than memorizing ability. It is also no doubt true that any test such as the Otis test which depends so much upon the factor of speed for high scores and the further fact that the sort of task demanded in the test is more like the tasks of school days unduly penalizes the older age groups.[18]

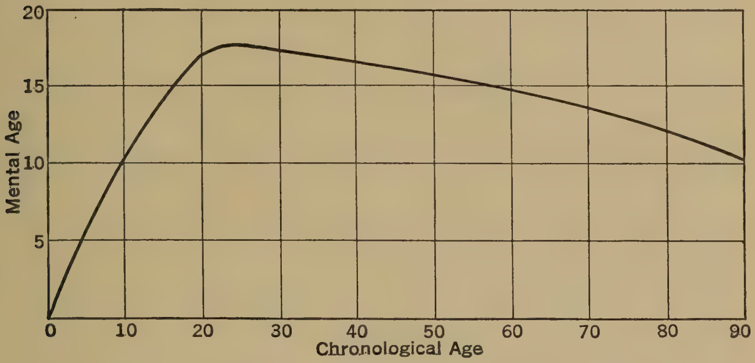

Figure 50. The Normal Course of Mental Development

Although the data do not bring out the fact practical experience indicates that the appearance and progress of mental decay varies greatly from individual to individual. Chief Justice O. W. Holmes, Chauncey Depew, and John D. Rockefeller are notable examples of men who have lived to a ripe old age and still retained vigorous minds. Many others reach "second childhood" before the age of 70.

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[17] E. L. Thorndike, *The Measurement of Intelligence,* Teachers College, Columbia University, 1925.

[18] There seems to be at least some support for this view presented in a study by Keith Seward, "A Study of Senescence," *Psychological Bulletin,* (November, 1931) Vol. 28, pp. 666–667.

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CHAPTER 13

THE GROWTH OF PERCEPTION

The Nature of Perception.—What is the nature of the world of the child at birth? James has described the child's first consciousness as a "big blooming buzzing confusion. That confusion is the baby's universe." From this primordial state the child must build up his knowledge of his later universe. The way in which this is done constitutes the problem of this chapter.

Two rather radically different views are held regarding this process: the orthodox view and the newer Gestalt view. The more traditional view holds that perceptions are built up out of sensory experiences and motor responses. By this view the child's first experiences are thought to be simple unelaborated responses to stimuli. These approach the character of pure sensory reactions. In terms of nervous functions these are supposed to represent relatively simple unelaborated pathways, with the simplest possible cerebral connection between sense organs and reacting mechanisms. But such types of experiences do not continue long in the life of the child. Possibly there is not more than one in each type of sensory experience. In the second and in succeeding similar experiences it is this first experience plus. This plus may, in its simplest terms, consist in further elaborations in the same sense department. These are called fusions. In other cases the additional material may come from other sense fields. These are called complications. In these ways our sensory experiences are elaborated.

Factors in Growth of Perceptions.—In addition to these complex or compound sensory factors, there are memories of former sensory experiences. Whenever a sensory experience occurs, memories of previous sensory experiences are aroused. Every time we see a dog, former experiences with dogs are called to memory. This may not occur in any conscious process, that is, we do not necessarily recall any single dog or all the dogs with which we have had experience. We do, however, call up the dog response which has been developed from our former experiences with dogs. These former experiences by means of associations have formed into this dog response and by association this former response is called up.

Thus far we have stressed the sensory and central sides of the process. However, there is another and similarly important side to this process. In any process there is a reaction. The child is making responses to these sensory elements. The child is forming ways of reacting to the world. These responses consist in reaching, grasping, looking, withdrawing, etc. At first these responses are mostly of the overt type. Later in life they are likely to take the form of language, spoken or written. There are, therefore; two chief modes of perceptual form, concrete and verbal. Although not mutually exclusive these two form large, somewhat separate fields of mental construction and elaboration.

We may illustrate the first of these in a more concrete way by describing the construction of the perception of an orange by the child. In his first experience with the orange he is likely to get certain sensory cues of color. In addition to these, the child will be very likely to take the orange in his hands. By this means he gets tactual and kinaesthetic experiences of the orange. He is also almost certain to put the orange into his mouth. This gives him more kinaesthetic and tactual stimuli as well as gustatory experiences. Thus we see that sensory impressions and certain motor adjustments are being built up into percepts. Of course, the orange has shape and size; but if the experience is a very early one, the child will probably not get much regarding size and shape. These, in themselves, are percepts or concepts which must be built up by experience.

Experience as a Factor in Perceptions.—As the child grows older, new information is gained regarding an orange. He learns where and under what conditions they grow, problems of transportation, sales, etc. If he lives or travels to the country where oranges grow, his information is greatly extended. Then when he sees an orange the meaning is very much more extensive. What happens, then, if at any time after the first experience the child receives some sensory cues from an orange? He will *perceive* an orange. It makes no particular difference whether the stimulus be visual, tactual, or gustatory. In any case he perceives the orange. The core of this perceptual process consists in what we may call the orange reaction. These reactions may be overt responses or they may be incipient, or more likely a combination of the two. If they are incipient, we may call them meanings. The whole psychology of meaning is somewhat obscure, but we may say briefly that meanings consist in the responses which a certain stimulus calls up through association. A book means the previous experiences we have had with it.

Perception depends upon the experience of the individual. Since these experiences are different for each individual they are always personal in character. William James tells of three men who made a trip around the world together. Their accounts of the trip were greatly different because of the difference in background of each man. The essentially personal character of each percept is well illustrated by the following well-known poem.

First blind man, falling against the elephant's side:
  "God bless me! but this elephant is very like a wall."
Second blind man, feeling the tusk:
  "This wonder of an elephant is very like a spear."
Third blind man, grasping the squirming trunk:
  "I see," quoth he, "the elephant is very like a snake."
Fourth blind man, clasping the knee:
  " 'Tis clear enough, the elephant is very like a tree."
Fifth blind man, catching the ear:
  "This marvel of an elephant is very like a fan."
Sixth blind man, seizing the swinging tail:
  "I see," quoth he, "the elephant is very like a rope."
        And so these men of Indostan
          Disputed loud and long,
        Each in his own opinion
          Exceeding stiff and strong,
        Though each was partly in the right,
          And all were in the wrong.

It is not to be understood that each previous experience has equal weight and that each is retained in full measure in the construction of our perceptions. Some of our experiences are vivid, others are relatively insignificant, while many are completely lost. Some are thrown out of perspective and others may be added without any basis of experience from other similar situations.

This last statement leads to another fact about perception. Many sensory experiences are not taken for their face value but are interpreted in the light of some other past experience. For example, the top of a table viewed from almost any angle is perceived as having right angles. In reality, only when seen from directly over or beneath any corner is the angle a right angle, and from that same position the other angles are not right angles. Yet they are *seen* as right angles. This reconstruction of the object to appear what it is rather than in terms of the immediate stimulus is nicely shown by drawings of small children and even by the unsophisticated adult. If the child is asked to draw the top of a table at which he is looking, he will draw the corners as right angles. Considerable training in perspective is needed to correct such drawings. In fact, more training is needed than is usually possessed by the average college student. This proves that all that is necessary is that the cue be sufficient to set off the previous meanings in order that we see things as they are rather than in terms of the immediate experience. This tendency to reconstruct or adapt the sensory material to the object perceived is greater than we ordinarily appreciate. It extends not only to shapes, sizes, and colors but to directions, distances, and to the character of the objects as well. Truly the world is often not what it seems, and equally it does not seem what it is.

Errors in Children's Perceptions.—In these reconstructions, as well as in the interpretations, errors are not uncommon. Several studies have been made of the perception of children. One of the most extensive of these was made by G. Stanley Hall,[1] in which he undertook to make an inventory of the contents of the minds of children entering the primary grade in the Boston schools. In summarizing his results Hall says,

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[1] G. Stanley Hall, *Aspects of Child Life and Education,* D. Appleton & Co., 1921.

> The high state of ignorance indicated by the tables may surprise most persons. . . . Skeins and spools of thread were said to grow on the sheep's back or on bushes, stockings on trees, butter to come from buttercups, flour to be made from beans, oats to grow on oaks, bread to be swelled yeast, trees to be stuck in the ground by God and to be rootless, meat to be dug from the ground, and potatoes to be picked from trees. Cheese is squeezed butter, the cow says "bow wow," the pig purrs or burrows, and worms are not distinguished from snakes. . . . While no one child has all these misconceptions, none are free from them, and thus the liabilities are great that in the chaos of half-assimilated impressions half right, half wrong, some lost link may not be utter nonsense or mere verbal cram.

Other similar studies have produced similar results. While open to the usual criticism of questionnaire and near-questionnaire methods and especially open to error due to the suggestibility of children, yet they do give us considerable insight into the errors in the perceptions of childhood. However, they are not all false.

There is another form of mistaken perception known as illusions. Illusions will be considered later in this chapter.

Perceptions in Children.—Many studies have been made of the growth of perceptions in children. Some of these have been described under the head of attention span and others as the growth of perception. In fact it is very difficult to distinguish between these two processes. Probably attention is generally looked upon as a more innate factor and perception as largely dependent upon experience, but this does not represent a clear-cut distinction between them.

Many of the older studies which did not clearly distinguish between attention and perception measured the rate of growth from year to year in the child. This was done by presenting a series of objects, often toys and small articles of various kinds fastened to a board, to the observer for a short time and then after they were removed the person was asked to name as many of the things he had seen as he could. Most of this work was carried on by German psychologists who computed age norms for their results. Some of the later experiments controlled the length of the exposure of the material by means of a tachistoscope. Lists of figures, letters, dots, nonsense, and sense material have been used as exposure material. The study of the span of eye movements in reading represents another form of such study. Several such methods have been incorporated into intelligence tests. Terman in revising the Binet tests, using an auditory method of presenting the material in the form of digits, arranged them by years as follows:

TABLE 5

Age in Years	Normal Auditory Digit Span
3	3
4	4
7	5
11	6
14	7
18 (superior adult)	8

The Binet test also well illustrates the growth of perceptions in other ways. In year 5 the child generally defines chair "to sit on," while in year 8 he defines a soldier as "a man who fights." A similar growth is illustrated in reacting to pictures. In year 3 the child simply names the objects and only a few objects at that. In year 7 he describes the pictures as, for example: "A man reading the newspaper. Some other men standing around." In year 12 he interprets the picture. This same picture is interpreted as: "A man reading some jokes. He has just gotten the paper at the store. Some other men are listening to the stories." Pintner and Paterson also present age norms for their tests. Some of these may be considered tests of perception.

Parts in Perceptual Process.—In the process of perceiving, two distinct parts are evident. The one we have been describing is the *elaboration* of our simplest experiences. This elaboration consists in the extension both in the number of our experiences and in the richness of each of these. Much of the life of the child consists in building and enriching these experiences. This takes place in the home. It is deliberately continued and enlarged in the kindergarten and elementary school. Even a large part of our high school program is directed to this end.

Another phase of the process related but distinct from elaboration of perception is the *differentiation* of one experience from another. Not only must the child evolve his idea of an orange, but he must learn to differentiate oranges from apples, lemons, grapefruits, limes, and tangerines. This is often a difficult but a necessary process. Just as the young child must learn not to call every man "papa," so must his older brother or sister learn to distinguish between an ellipse and a parabola, a gerund and a gerundive, wrought iron and cast iron, or a quartz crystal and a diamond. Such distinction must go on between objects, relations, and symbols. Language as a form of symbolism presents a most important field for discrimination. This topic will be discussed in the following chapter of this text.

Age Differences in Perception.—As yet there have been few experimental studies in perceptual ability with later maturity and old age. Recently Miles[2] and some of his students have been working on this problem. By means of the tachistoscope he exposed series of objects to people of various ages and had them report what they could remember of what had been exposed to their view. In the experiment 720 subjects were used, ranging in age from 7 to 92. Miles found a rapid rise in perceptual ability from 7 to 17. Beyond this age there was a gradual decrease in ability but the decrease was slight up to the age of 40. At 40 the perceptual ability was equal to that of a young person of 15. At 50 it was equal to age 14; at 60 to age 12; at 70 to age 9; and at 80 to age 6. From these results it is seen that there is a rather rapid decline in perceptual ability after the age of 60. This decline is considerably more rapid than that obtained by Miles in intelligence test scores. It does not seem unreasonable to suppose that perceptual ability of the type measured by these tests does decline more rapidly than mental ability. Perceptual ability is only one factor in intelligence and it is probably one of the more transient factors.

Social Perceptions.—There are yet other fields in which the child must build up perceptions. He must learn to perceive when and how to approach father, mother, or teacher. In this field small cues must be rightly interpreted. Skill in getting on with people is an important factor in modern society. Such skill depends primarily on two things: interpreting (perceiving) the behavior of others and developing a form of reciprocal behavior in ourselves to fit into the social situation. Custom is one important element. Dashiell tells of the fond parents who took their small child to a formal wedding. When the child cried, the parents mistook the looks of those present for expressions of approbation. While there is little intelligent justification for many of our social customs, the cultured individual at least needs to know when as well as why he is breaking them before doing so.

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[2] See an Abstract by W. R. Miles, *Psychological Bulletin,* (November, 1931) Vol. 28, p. 667.

In present-day politics it is not always the most intelligent leaders who are elected to office. Often it is the person who best interprets the will of the majority. Of course, he may not always work for the best interests of his constituents, but he must at least convince them that he will do so.

Aesthetic Perceptions.—Another type of perception is in the field of aesthetics. We build up notions of balance, harmony, rhythm, form, etc. Just how we build up our percepts in any field, such as music, would make an interesting story. The fact that music has evolved from the beating of sticks on other pieces of wood and from rude howls and cries shows that it is a matter of growth. The modern child has to recognize the cues and principles of music, painting, and other forms of art. Whether he learns to enjoy jazz or classical music, classical or modernistic art, Shakespeare, Browning, Sandburg, or Edgar Guest or none of these, will depend upon his experiences.

The Gestalt Approach to Perception.—In the study of perception there is another relatively recently developed point of view which deserves mention. Wertheimer in Germany was responsible in large part for its development and in this country Koehler and Koffka have been its chief exponents. It is called the Gestalt or Configuration school of psychology. This point of view has already been briefly described in some of the preceding chapters. However, it was in the field of the perception of movement that it had its real beginning. Later it was extended to problems of learning and more recently to the whole field of psychology. Some of the views of the Gestalt school are not new; they are rather new emphases. Others of their principles are new.

In perception the emphasis of the Gestalt psychologist is upon the analysis of the percept from an undifferentiated background. Perceptions are an analytic process for this school as contrasted with the synthetic emphasis of the older schools of psychology. Indeed, as has just been intimated for the Gestalt school, the process of perception is that of separating the "figure" from the "background" or "field." The figure gives the perception but it gives it only as set in a background. The figure cannot exist without a background. One is the complement of the other.

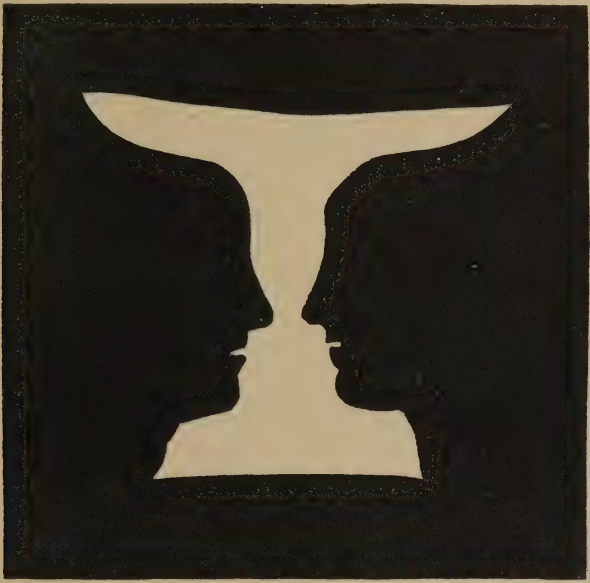

Figure 51. Illustrating Possible Reversal of Figure and Background
(E. Rubin, *Visuell wahrgenommene Figuren,* 1921)

In some situations the relation of figure and background may change. For example in Figure 51, first presented by Rubin, either the white may be figure or it may be background. If it is figure the picture will be seen as a kind of urn; if it is seen as background it will show two silhouetted faces looking toward each other. From this it is seen that what is figure and what is background in any perception is not something inherent in the stimulus as such. It is rather in the way in which the stimulus is viewed by the observer. It is, of course, clear in this case that the stimulus remains objectively the same whichever way the above figure is viewed or if the characters change during the time it is being observed. Although the above figure is unusually susceptible to either view many others are capable of similar reversals. The two drawings in Figure 52 may be seen in several different ways. The cube may be viewed with either of two sides as the front. The other figure may appear as a flat surface or as three cubes and the cubes may appear with one on top or as with two on top.

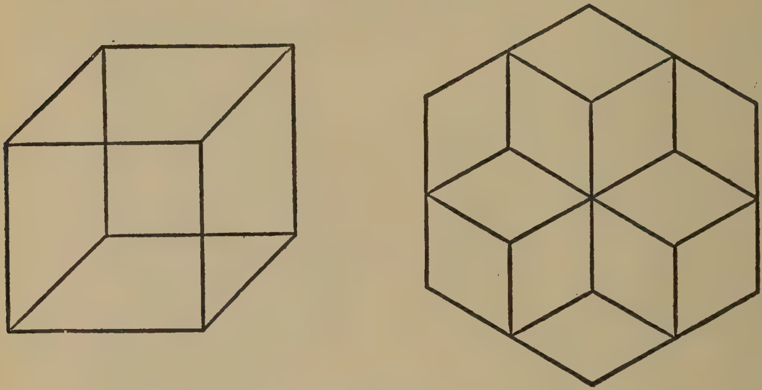

Figure 52. Two Ambiguous Cube Figures

There is really no excuse for seeing anything here but the perfectly good flat figure which probably appears first—no excuse, except our proneness to see solid, three-dimensional objects in all figures that admit of such interpretation.

(R. S. Woodworth, *Psychology,* Henry Holt & Co., 1929)

The realization of the relation of figure and background is not new. It is rather a matter of a new and important emphasis. It is also true that the principles governing the perception of figure and background can be adequately explained by the laws of learning and habit formation.

The configurationists stress the fact that perception is primary and that sensations are derived as an aspect or quality of perception. Perceptions, they say, are not built up by experience from simpler elements like sensations, memories, and simple responses. They are derived by a process called "insight" from total experiences. While by analysis the percept may be said to contain sensory elements, the whole—the percept—is not the sum of its parts—sensations.

This emphasizes the unitary character of perceptions. Perceptions are not composites of anything. Even the stimulus-response features of the older schools of psychology are considered by the configurationists as making up a unitary inseparable continuum.

The emphasis of the configurationists on the unitary character of perception and that the perception may be broken up into elements, but only in an artificial sort of way, may not be entirely incompatible with other views regarding perceptions. May it not be true that percepts are derived both by analysis and synthesis? In looking at some new and strange picture or object may we not both see "figures" on "backgrounds" and construct figures from elements? It seems reasonable and likely that we get perceptions by both methods and that one is only the complement of the other. If this be true we can accept certain new principles proposed by the Gestalt school, other principles may be looked upon as new emphases, and certain other principles must be rejected. This, in general, is the history of any new movement in almost any field.

Perception of Space.—There are two other fields in which the child must develop perceptions. These are space and time. How does the child get his notions of position, size, and distance? There has been much controversy over this question. One group holds that such perceptions are nativistic; that is, they exist from birth and do not have to be learned. The more modern view is that the *capacity* for space perceptions may be native, but our ideas of space are built up as a result of space experiences. While the space perceptions of some animals seem amazingly perfect from birth and the ability of very young human infants to turn the head in the direction of loud noises or bright lights may seem to be unlearned, the evidence is not conclusive that space perception is innate. Most, if not all, of this, as well as later ability, depends upon experience with objects in space.

Many of the senses are concerned in the process of building up space knowledge; but the tactual, kinaesthetic, visual, and auditory senses are the chief ones. It is difficult to tell which senses the child uses first. Probably they all develop together.

Perception of a Single Point.—While not the first, the simplest problem in space perception is the perception of a single point upon the skin. If some one touches us upon the hand, we can rather accurately locate the point touched, even without using the sense of sight. What is there about the sensory cue from one part of the body which distinguishes it from all others? This differentiating element has been called "local sign."

There is still much to be learned about local signs, but there are some things that we do know. The local sign for any area is not entirely dependent upon the sense organ or nerve supply for the region. It would be very reasonable to suppose that each sense organ or each neuron has its own local sign. It is true that the number of local signs in any area is roughly proportional to the nerve supply. The finger-tips are especially well supplied. The tongue and lips are also well supplied with local signs. The median line of the body and extremities are, in general, better supplied than the lateral areas, and movable parts better than immobile parts. The back is very poorly supplied. These facts all point to the relation between nerve supply and local signs. However, it has been found that local signs are modified by training. This eliminates the possibility of local signs being a matter of individual nerve endings.

Linear Space.—In the perception of linear space upon the body, the idea of local signs has been extended. It has been assumed that linear space is due to a succession of local signs, as when an object is drawn across the skin. This is not so easy to believe as the single point local sign. Again, we can estimate the distance between two points when the intermediate points are not stimulated. This has been explained by the filling in of the intermediate local signs in imagination. This seems even more unlikely, even though we have no better explanation to offer. As a further extension of the idea of local signs, plane surfaces or areas have been looked upon as a further extension of local signs.

This process of space development through the tactual sense does not go on alone. Closely related to it is the development through the kinaesthetic sense. The perception of a position in space may be mediated by the local signs from the kinaesthetic sense. Linear space is due to the local signs from the joints, tendons, and the respective muscle groups concerned. Some complications arise here since the same sense of movement may result from either the movement of the finger muscles, the wrist muscles, or the elbow.

Perception of Solid Figures.—Three-dimensional space is probably not discernible by the tactual sense alone. Here kinaesthesis is important. The movable parts of the body, especially the hands, may be moved in any one of three dimensions. In this wise they are used for exploring solid objects. In order to see how this is done, watch the small child or a blindfolded adult when presented with some object. He will be sure to run his hands over the object in all directions. In addition, the child will be almost sure to bring the object to his mouth. Here he will get more tactual and kinaesthetic experiences. Stern believes that the mouth of the young child is especially sensitive and hence important in ascertaining shapes and forms, as well as structure.

Tactual and kinaesthetic perception of space have been described before perception of visual space because they are used first as primary modes of exploration. The child can see from birth, but visual space perception at first is not so accurate as tactual and kinaesthetic senses. It is the latter which the child uses to get his exact knowledge of space, and then vision is gradually substituted. This substitution is important, since the child soon begins to act toward objects beyond his reach.

Many of the same general assumptions must be made in visual space perception as in the other senses. We must assume local signs, not only in the rods and cones but also in both the intrinsic and extrinsic muscles of the eyes. In addition to these, the kinaesthetic local signs from neck muscles must be included.

By means of these local signs the various kinds of visual space are to be explained. A point in space is perceived by local signs from either or both eyes. Linear space is perceived by the movement of the eyes, and areas by exploring the edges of the object. Depth and distance are very complex. There are some monocular factors in depth and some binocular factors.[3] The principal monocular factors are:

1. *Accommodation.* The adjustment of the internal muscles of the eye which takes place in fixating upon an object. The degree of this adjustment becomes a cue to the distance to an object.
2. *Relative size of familiar objects.* Other things being equal, the farther an object is away from the observer the smaller the retinal image. Therefore, when the size of an object is known, the relative size of its image gives a clue to its distance.
3. *Shadows and shading.* Objects farther distant from the observer have more shadows. This is used as a criterion of distance.
4. *Elevation above horizon.* Objects higher on the horizon are farther away otherwise they are not within sight.
5. *Superposition.* Any object which partly obstructs the view of another object is nearer than the object obstructed.

The principal binocular factors are:

1. Ordinarily the two eyes focus upon any object, since the angle of fixation is slightly different for the two eyes and the amount of the difference is dependent upon the distance of the object from the observer, this difference gives a cue to the distance of the object.
2. Fusion of retinal images. Due to the fact that there is a slight disparity between the two retinal images and this disparity is greater the nearer the object to the observer this cue is used to estimate distance.

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[3] For a fuller discussion of these factors see A. R. Gilliland, J. J. B. Morgan, and S. N. Stevens, *General Psychology for Professional Students*, D. C. Heath & Co., 1930, or Knight Dunlap, *Elements of Scientific Psychology*, C. V. Mosby Co., 1922, Ch. VIII.

By the use of these cues, although their use is generally unknown to him, the child builds up his knowledge of visual space. Gradually these take over the duties of the other senses and become more accurate than touch and kinaesthesis alone.

Auditory Space.—The child also learns to localize sounds and noises. How does he do so? What differences exist as possible cues between a sound at the front and to the left of the hearer and one at the front and to the right or one from behind? Two chief differences exist and there is good evidence that both are used in localizing sounds.

One is the relative intensity of the sounds to the two ears, and the other is the difference in time of the arrival of the sounds to the two ears. A sound coming from the right of the hearer will strike the right ear with more intensity than the left ear. The farther it is to the right, the greater this difference will be. The sound coming from the right will also arrive at the right ear before it does at the left. Although this difference in time is small, at most not more than one sigma (thousandth of a second), these extremely small intervals of time help form the basis for discrimination.

It is true that a sound coming from 15° in front and to the right of the hearer has the same intensity and time relations as a sound 15° to the right and behind the hearer. Here the differences are probably due to the fact that from behind, the pinnae tend to screen the sound and, when it is complex, to filter out more of the short waves than of the long waves. When sounds have these characteristics, they are located as coming from behind.

Perception in Time.—There is also a difficult problem in the perception of time. Many theories have been advanced but little experimentation has been made on this subject. It is probable that there are two rather distinct methods used in time perception, one for short intervals of time and another for longer periods.

One of the most reasonable theories for the perception of short intervals of time is by reference to breathing, heart beat, or some other body rhythm. Either consciously or unconsciously the perception is made by counting or estimating these body processes during the time of estimation.

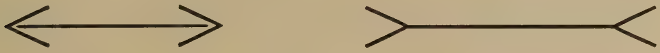
It has been found that what takes place during the estimation is a large factor in the perception. If the interval is filled with interesting events, the time will be underestimated. If it is uneventful or boresome, the time will appear long.

Longer intervals are perceived in other ways. How does the student know, without referring to his watch, that the recitation period is almost over? Here the amount of fatigue or rest or the amount that has transpired is used as a cue. Secondary cues such as the position of the sun, the approach of darkness or light, the coming of the milkman or postman may be used as cues.

The child, of course, must learn to use such cues in his estimations. Some learn to use them more effectively than others. In some walks of life, time is not so important; in others it is most important. While the trainman constantly refers to his watch, he is also making use of other cues all the time. The child who is permitted to go to a neighbor's to play for fifteen minutes is likely to be impressed with his lack of observing time if he stays an hour.

Errors in Perception.—In an earlier part of this chapter some of the common errors of perception in children were described. It must not be thought that these are the only kind of false perceptions. There are all sorts of errors in perception for adults as well as for children. Every time something is taken for what it is not, whether it be a counterfeit coin or a spirit message, it is a false perception. In fact, a perception does not have to be completely false. There are some elements of truth in most perceptions; likewise there are some elements of falseness about all of them. Almost any good cross-examination will bring this out. In fact, it is impossible for any perception to be entirely complete. All knowledge is relative.

Another type of false perception is given the name of illusion. In any illusion some factor or group of factors is responsible for the perceptual error. In the famous Müller-Lyer illusion the base line is judged longer when the end lines extend out than when they extend back over the base line. While the explanation for this or any other illusion is often not clear, such perceptual errors are universal. By this it is meant that every one viewing the illusion will make the same type of error. No normal person looking at the two parts of the common Müller-Lyer figure will see the two base lines as the same length. Furthermore, training will not overcome this error in estimation.



It is true that this estimation is based upon experience. It is experience which is fundamental and which is common to all normal persons. Most illusions are of this nature. However, if the illusion is viewed from some unusual position or is otherwise distorted, it may disappear. Other conditions may produce similar effects. The writer has never been able to get the Aristotelian illusion of placing some small object between the crossed first and second fingers.

Another type of false perception, which Woodworth also calls a false sensation, is known as hallucination.[4] In hallucination there is the perception of a real object without any apparent sensory cue. Auditory and visual hallucinations are most common, but tactual, olfactory, and gustatory hallucinations are sometimes encountered.

Contrary to popular opinion, perfectly normal persons may have hallucinations. The chief difference is that they are not nearly so common with normals; but almost everybody has had the experience of thinking that he hears some one calling him, especially when anticipating a call, only to find that no call is being made. This is one of the conditions facilitating hallucinations, that is, a condition of anticipation. Other causes are fatigue, poisoning, alcoholism, or fever.

As has been indicated, hallucinations are most common with the insane. The origin of such hallucinations is not easy to explain. In some cases there may be irritations in the sense organs or along the nerve pathways. There is a problem here as to just how these become interpreted in the way they are. There must be some predisposition in the direction of the perceived object.

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[4] For a fuller account of hallucinations see J. J. B. Morgan, *The Psychology of Abnormal People,* Longmans, Green & Co., 1928.

Another cause of hallucinations is some disturbance in the personality, some conflict, emotional disturbance, or thwarted drive. If the drive is thwarted, the person may withdraw into reverie or day-dreams. These may take on so much reality that the person really believes the wish to be real or fulfilled. Hence in the insane asylum we will find many "Gods," "Caesars," "Napoleons," many voices are heard telling of divine appointments, radio messages are received, etc. The counterpart of these conditions is to be found in devils, accusation of the commitment of the unpardonable sin, poison in foods, and the like. As already suggested, no one account will explain all of them. Here is a place for preventive mental hygiene—for prevention of the development of hallucinations is much easier than effecting a cure.

Concepts.—This chapter has been concerned with the problems of the perception of objects within the immediate sensory experience of the individual. Man also uses another form of mental content which is not so limited. It is not limited, in the sense that the object need not be within the sensory range of the person, and furthermore, it represents a class of objects rather than any individual object. Such mental equipment is called a concept. Much of our thinking is in these general terms rather than in the concrete.

When I think of such things as goodness, whiteness, a house, or virtue, I think of them in terms of qualities or abstractions. The child develops these concepts by analyzing the qualities from their possessors. The child never sees white. He sees objects which are white. We never experience justice. The child learns to see that in any certain situation, this or that thing is just. Out of such experiences he formulates certain ideals or principles of justice.

While the child sees many houses in his thinking, he may think of a particular house or he may think of the class of objects called houses. Concepts represent tools for thinking. Just as the unknown quantity has been valuable in mathematical calculations, so has man learned to use the general symbolism of the concept in his thinking.

Words may represent percepts or they may represent concepts. In thinking and all higher thought processes, concepts play an important part.

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CHAPTER 14

LANGUAGE

Language is, no doubt, the basis of man's chief advantage over the rest of the animal kingdom. If man should suddenly lose his language and all the culture he has gained through language, he would be most seriously handicapped. In a preceding chapter the problem was raised as to the possible effects of such a calamity. While all of his heritage would be lost, man would, no doubt, still be able to adapt himself to the problems of life better than any of the other animals. This fact has sometimes been minimized by students of animal behavior who have become strongly impressed with the accomplishments of some dog, monkey, or higher ape; for example, Romanes was impressed with the behavior of the dog, Koehler with the apes with which he spent most of his time for some years, and Yerkes also with apes, which he considered "Almost Human."

Whatever the basis for his superiority, man in his present state is above other animals in features which do not depend either directly or indirectly upon the use of language. Man can learn to run mazes, perform acts of skill, and meet the problems of existence better than any other animal. We marvel at the tricks performed by trained animals in the circus or on the stage; yet we would not be impressed by similar tricks by man. He must do vastly more. The tiger jumps from one simple trapeze to another, and it is considered a great feat. Man must turn somersaults high in the air jumping from one swinging trapeze to another to gain praise.

In our recital of differences between man and the other animals, we must remember that man has the *capacity* to acquire language and that animals do not. If it were a matter of opportunity only, many pet dogs and cats would acquire a better language than some children. It is true that some animals, notably the parrot, may learn to say several words; but saying words is not using language. Language consists in using certain sounds, movements, marks, or other kinds of sensory stimuli as *signs* for certain things. These signs must be understood by both the producer and the receiver of the sign. A dog or a monkey may be taught to "lie down," "speak," "roll over," etc., but no dog has ever been taught to give such signs to other dogs. Of course, in a sense when one dog growls at another that act may be interpreted as a sign. Whether or not this may be considered as a rudimentary form of language depends largely upon the interpretation of our definition. But even in this case the cue is concrete rather than symbolical. Possibly the only real difference between the language of man and the methods of communication used by other higher animals is one of degree. If this be true, the degree of difference, however slight it may have been at one time, is great at present.

The Origin of Language.—Before considering the many theories which have been proposed to account for the origin of language let us first consider the sources upon which they have been constructed.

One of these is by the study of retarded races of modern times. Some of the races which have been studied are those in the interior of Africa, in the East India Islands, and the American Indian. Interesting as these studies are, no race living furnishes a satisfactory basis for the discovery of the origin of language. Every known living race has a language which has long since lost the essential character of its origin. Its modifications have been so great that it would be at least almost as easy to trace the origin of English or almost any other of the well-known modern languages.

Another method is by the study of the earliest languages known to history. The Egyptian and Assyrian are two of those commonly studied. Here again our records are limited to written forms. Written language is always developed later than spoken language. Furthermore, all these early languages were old before we have any records of them. This method contributes more than the former method but its limitations have already been pointed out.

We might study the forms of communication used by apes and other social animals. Yerkes and Learned did this with their two monkeys Chim and Panzee. This method, no doubt, gives us some clues, but we do not know how nearly the methods of communication used by such animals simulate that used by early man. That it is different is evidenced by the fact that man developed a real language and, however close they may have approximated this condition, the other animal forms never evolved a language. There must, therefore, have been some essential differences between them and it is impossible to distinguish which these are.

We may also study the origin and development of language in the child. Here the problem is complicated by the fact that the child hears a language spoken before he even realizes its use. As the need arises, the tools are ready and awaiting his use. In fact, any attempt at much originality is frowned upon by his elders. The child must learn to use what has already been provided for him. This changes the character of his problem so much that we cannot be sure what parts of the child's problem are to be compared with that of prehistoric man.

Thus it is clear that any attempt at an explanation of the origin of language is highly inferential and problematical. The facts available are very meager and sketchy. It would help materially if it were possible to obtain some additional earlier records or to resolve the problem to some experimental attack.

There is an interesting myth of Psammetichus, king of Egypt, who wanted to find out whether Phrygian or Egyptian was the more primitive language. In order to determine which was the more primitive, two infants who had never heard a language were reared together in isolation until they were several months old. When they were brought before the king one of them said, "Bekos" the Phrygian word for bread. So far as is known, no similar experiment—many Sunday supplement stories to the contrary notwithstanding—has been performed since, despite the fact that much of interest could be learned only by this method.

The nearest approach to such a condition are the cases of congenitally blind and deaf children. These unfortunate people are cut off from the culture of their surroundings until, by some means like that used by Helen Keller, tactual or other stimuli are substituted for the other common forms of communication such as audition or vision.

But even in the many cases of congenital deafness and blindness less fortunate than Miss Keller, there are many conditions in which social influences based upon the language of others modifies the environment of such individuals. They receive the benefits of modern inventions and discovery. They are cared for by people who have benefited by language and the majority of them who have normal mental capacity learn some form of language communication. Hence they do not contribute much to the problem at hand.

From the sources already described and, no doubt, even more from the imagination of the writers themselves, a profusion of theories have been proposed to account for the origin of language. A few of the better known of these will be mentioned here, not so much for their inherent worth as to give an idea of what has constituted one of the hottest contentions in the field of philology. In fact, it is reported that about three-quarters of a century ago the discussions became so violent that for its own protection the French Academy forbade any further discussion of the problem.

Three of the theories which were most widely discussed about this time were the onomatopoeic (bow-wow), the interjectional (pooh-pooh), and the Müller, (ding-dong) theory. While the authors of these theories would not agree to the statement, the real difference between them is for the most part only one of the degree of definiteness of the relation between the word and the thing it represents. By the onomatopoeic theory it is assumed that there is a very definite relation. All words are derived from the things they signify. Such an explanation accounts for such words as "hush," "bang," and "cough." Suffice it here to say that there are many words that even the most fertile imagination would have much trouble in accounting for by such an explanation. How, for example, would this theory explain the origin of the various forms of the verb "to be"?

The interjectional theory attempts to account for words as natural outcries of animals and man. "Oh" and "ah" are easily accounted for in this way. After a small list of such words has been compiled as fitting such an explanation, few others can be accounted for by this theory.

Max Müller claims there is a certain relationship or harmony between words and things. This is, no doubt, another form of the double aspect theory so common to the older philosophy. The theory may be questioned on two grounds. First, on the basis of fact as to whether such harmony does exist, and if it does why there are so many different languages and these ever in a state of flux or change. Second, if the harmony exists, the only change to be expected would be a result of a change in the things themselves. This does not seem to be true.

Pillsbury[1] criticizes all three of the theories on the basis that they assume that men's minds were filled with ideas or concepts and that they were consciously seeking to find some method of communicating these ideas to their fellow man. Pillsbury thereupon proposes a modified form of Wundt's theory that language is an outgrowth of instincts and emotions. In the presence of certain things certain things are instinctively done. These responses are both manual and vocal. From the manual side of the response gestures are developed. From the vocal part, spoken language is developed. The cries and other vocalizations of animals are a beginning of language. Man used more of these than other animals. He learned to interpret them and he modified the forms of expression. He developed meanings and lo, he had a language. Although appearing more reasonable than the other theories, its one most serious fault is the gap in the explanation explained only by the word "lo."

Judd[2] suggests that many words were chance vocalizations, especially by the elite members of society, which were accepted and became the common expression of an idea. Although it was new only in the sense that it was a variant of a common word, President Harding was credited with coining the word "normalcy" in his expression "back to normalcy." This explanation accounts for many new words in a language. It easily accounts for proper names and so nicely for nicknames. It also accounts for many common nouns as well.

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[1] W. B. Pillsbury and C. L. Meader, *The Psychology of Language,* D. Appleton & Co., 1928, Ch. VIII.

[2] C. H. Judd, *The Psychology of Social Institutions,* The Macmillan Co., 1926, Ch. X.

There is another source for words, after a certain number have been coined. This is by the separation of words into parts. Especially the highly inflected languages furnish ample roots, both suffixes and prefixes which may be formed into separate words. Furthermore, words may be combined into compound words. The German language is especially rich in words which have been formed by combining other words.

No one of these theories accounts for all the words in any common modern language. No doubt each of these methods has contributed a part. Probably other sources not included in any of the accounts have contributed to the rich complex of man's present means of communication.

One question which has already been mentioned warrants further consideration. Did man first have ideas and then evolve methods of expressing them, did language accompany the development of ideas, or did language develop first and then gradually come to be used as a means of communicating ideas? Vendryes[3] believes that thought and language developed together. Certainly the two were very closely associated. No very great need arose before some method of expressing it was evolved. But, just as the child first understands and later learns to speak, probably prehistoric man vaguely realized his need—he was afraid, he was hungry, or he was angry—before he expressed his feelings to others. As his wants grew and his means of expressing them improved, man progressed further beyond other animals. He began to be able to consider past events and to prepare for the future. He ceased to be confined to the concrete and began to deal in abstractions. By language he transmitted his culture to his fellows and offspring. Such is a brief account of man's progress.

Early Forms of Expression—Gesture.—It has been suggested by some writers that any one of the senses may be used for receiving the symbolisms of language and any form of behavior possible for expressing thought. One of the early and important methods was by gesture. Animals make gestures and early man made gestures and elaborated them. The American Indian still makes much use of them in expressing his wants. We all use gesture in amplifying our speaking both in public and in private. It is a common form of expression between people who do not speak the same language. Before the introduction of "talkies," moving picture actors had to become very skillful in depicting ideas and emotions by gesture.

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[3] J. Vendryes, *A Linguistic Introduction to History* (Radin), Alfred A. Knopf, 1925.

Gestures might have become the principal form of communication except for certain limitations as compared with speech. Chief among these is the fact that the person to whom we communicate must be looking or he will not see our gestures. Gestures ordinarily cannot be made effectively in the dark. Again it is impossible to gesture effectively when our hands are otherwise occupied.

Hence the voice has taken chief place in communication. The principal use for the organs of speech is respiration. Even the vocal cords have a primary function of closing the opening to the lungs during swallowing. Even though not developed primarily for that purpose certain of the organs of respiration have been appropriated as organs of communication. As such they are very effective. They have the capacity of variation in three ways: in (1) vocality, (2) loudness, and (3) quality. There are more than fifty distinct and different elementary sounds which can be produced by the human voice. The voice can be regulated for distance and for the acuity of the hearer and for the expression of strong feeling. By quality we refer especially to the ability to express slight shades of meaning but it may also include good inflection and enunciation. For these reasons the voice offers many advantages over other means of expression and has been generally adopted for direct personal communication.

Whether all languages developed from one common parent language or whether several languages were evolved simultaneously is a disputed point. There seems to be several fundamental likenesses between all languages. This might possibly point to one common parent language. On the other hand, as

Sapir implies, it may indicate the common fundamental agreement in human modes of thought and expression and not necessarily to one common source for all known languages.

A further mystery in the origin of language is the orderliness with which language developed. We refer specifically to grammatical forms. If a new language were to be formed, the normal method would be to evolve a framework—a grammar—and fit the forms into it. That is, certain laws, parts of speech, inflections, etc., would be worked out. It was somewhat like this that Esperanto, the proposed universal language, was developed. However, in actual practice real languages evolved in just the opposite way. The grammar was the last thing to be written. Jesperson[4] tells us that it was Plato who first called attention to parts of speech. Yet parts of speech, moods, tenses, numbers, inflections, etc., did arise and, in general, according to certain principles or laws. While these differ from language to language they are, with relatively slight exceptions common to all important modern languages. How may this general structure be explained? No language or other complex structure just grew up. The basis for language must have been the fundamental logic or inherent reasonableness. The human mind must function in certain ways, and language is an expression of this method.

The argument, however, cannot be pressed too far, for languages do differ in certain respects. There are many differences between Sanskrit, Chinese, Hottentot, and the English language. There are even differences, as we all know, within these languages. The language spoken in America differs from that spoken in England. That spoken in Boston differs from that spoken in New York or Atlanta. How are these differences to be accounted for?

Whenever there is a lack of social contacts, the causes which are always at work in changing language forms are intensified. Where these differences have gone on for a long time, as has been the case between the common sources of Chinese and English, if they had a common source, the changes have become very great. New forms have arisen. Some one has expressed himself in a new way—possibly our modern writers of free verse are examples in point—these forms have been copied and, as a result, changes have come about. But through all of these changes certain principles of thought have remained permanent. This is all that would be necessary to account for the similarities in grammar.

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[4] Otto Jesperson, *Language, Its Nature, Development and Origin,* Henry Holt & Co., 1922.

Written Language.—What has been said thus far applies to spoken language. Man also expresses himself through visual symbols as well as auditory symbols.

While written language has been a much later acquisition, it has been none the less important. It has been the stabilizer of thinking; it has been the preserver of thoughts. By means of written records man can tell what he thought and did in such a manner that not only his fellow man but also later generations can know about these facts. Modern man has learned much about the thoughts and habits of living of the Babylonians, Phoenicians, and Egyptians from the writings on their monuments and tombs. Professor Breasted of the University of Chicago and others have contributed much information concerning early Oriental civilization by deciphering these inscriptions.

How did man begin to write? Judd[5] says that such beginnings were entirely independent of spoken language. Writing began by the drawing of pictures. Some of the oldest known forms of these are to be found on the walls of caves in Europe. Others are found scattered in various places all over the world. Sometimes these pictures were drawn for the entertainment of the drawer. In other cases they were to give information to others. A sample of the latter is a drawing on the rocks in eastern Oregon. This drawing pictures a herd of buffalo and two suns. This was some Indian's method of telling the story that buffalo will be found two days' journey from this point.

The information that can be given by such drawings is limited to the concrete. Abstract ideas are impossible to express except indirectly and by inference. As picture writings became more widely used, convention made it possible to make certain abbreviations and symbolizations. Among the Egyptians, for example, the ostrich feather in addition to its literal meaning came to stand for justice. This symbolism was based upon the idea that all ostrich feathers are the same length. A roll of papyrus came to represent knowledge, a form of symbolism still used on seals, coats-of-arms, etc. In the same manner, a brandished whip was a symbol of power. The Dakota Indians indicated an abundance of food by a drawing of a pit with a buffalo head within and a supporting forked stick. Gestures were sometimes illustrated in drawings. Hunger was represented by a heavy bar across the abdomen. The cross, an imitation of the crossing of the arms, represented the act of barter or sale.

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[5] Judd, *op. cit.*, Ch. IX.

Gradually the drawings became more conventionalized symbols for the object or idea signified. By such means the possibilities of communication were extended and the capacity to express abstract ideas increased. Of course, such a representation was possible only when both writer and reader understood the symbolism. This is always a necessary condition for the use of any form of language.

A further extension in the field of writing came in the form of representing spoken words with pictures. This was a form of rebus writing. Huey[6] describes how in some old Egyptian records their god Hesiri was represented by two words "hes" and "iri." Although these words meant respectively a seat and an eye, they were used to refer to the god. This was done by drawing a picture of a seat and an eye to represent the god. Such rebus methods were used in conjunction with cuneiform writing in some of the Phoenician records.

This also illustrates another step in the process of writing; that is, the breaking up of a word into syllables. In this process the influence of spoken language is evident. The symbol used stands for a spoken syllable. The Chinese language is the best example of this. The Chinese have 1,144 phonetic signs or phonograms. These may have more than one meaning. For example, Taylor[7] has pointed out that the syllable "pa" has eight distinct significations. The difference between these is made evident by the use of a descriptive character. When "pa" is followed by the characters for plants, the combination means a banana tree; when it is followed by the character for iron, it means war chariot; when followed by the character for sickness, it means scar. Thus by the use of the 1,144 syllable symbols and 214 character signs or ideographic keys, as they are called, 40,000 Chinese words are produced.

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[6] E. B. Huey, *The Psychology and Pedagogy of Reading,* The Macmillan Co., 1914.

[7] Isaac Taylor, *The History of the Alphabet,* Charles Scribner's Sons, 1899.

At this point of development the Chinese written forms became static and remained so for centuries. Only recently has there been any advance toward the formation of an alphabet.

The cuneiform writing of the Assyrians and Babylonians was also largely syllabic in character. It was the Egyptians who made the next, and in many ways, the most important single step in the perfection of a written language. This was the construction of an alphabet. This came largely by using the initial sound of a syllable for a letter sound. Judd quotes from Taylor to show how the letter "M" was evolved from the picture of an owl. By the use of the letter symbol a form without meaning itself becomes the means for representing meaningful words. This is equivalent to the introduction of the unknown quantity in equations in mathematics. It has the advantage over the mathematical unknown of being easily and directly translated into values and meaning. These facts are further illustrated in the accompanying figure which shows not only that the picture represents a single sound but also that the picture has changed through several stages to almost its present form. By means of a relatively few symbols standing for elementary sounds, it became possible to represent any word. Forty-five characters came to represent the alphabet for the Egyptians. By means of symbols the syllable and the word could be built up. But the Egyptians never fully appreciated the importance of their invention and continued to include needless syllabic signs and ideagrams. "So many crutches were thought necessary that walking became an art of utmost difficulty," says Huey.

There is some dispute as to just how the Egyptian alphabet was introduced into Greece. Huey suggests that it was probably first borrowed by the Semites and from them by the Phoenicians. The Greeks, in turn, borrowed it from the Phoenicians. Several changes, of course, occurred in these exchanges, but the story of our own alphabet can be traced with considerable certainty back to these early sources.

The form of the letters has also been changed. Several practical considerations have helped in this process. The instrument used in writing was an important factor. The straight-line forms of our capitals, which came from the Romans, were determined partly by the ease of the formation of the letters with chisels on the hard stone surfaces of monuments. The Roman Script represented a form most easily and rapidly produced by the use of a quill or pen. The round letters, such as "e" were more easily produced by a pen than the "E" form of the letter. Printing introduced new problems in letter formation. Many different letter forms were tried. Three different kinds have had much vogue; the Italian form, represented by the modern italics, the German angular form, and the common English form. The present tendency seems to favor the general adoption of the more simple and legible English form.

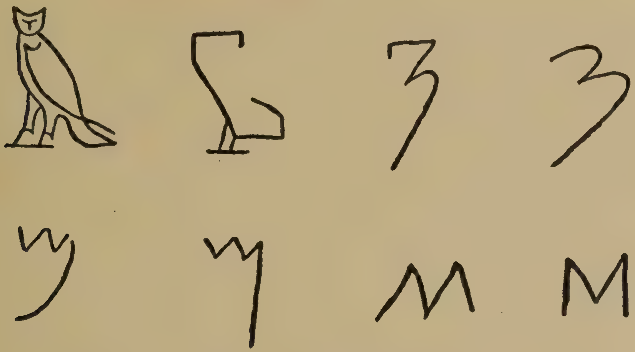
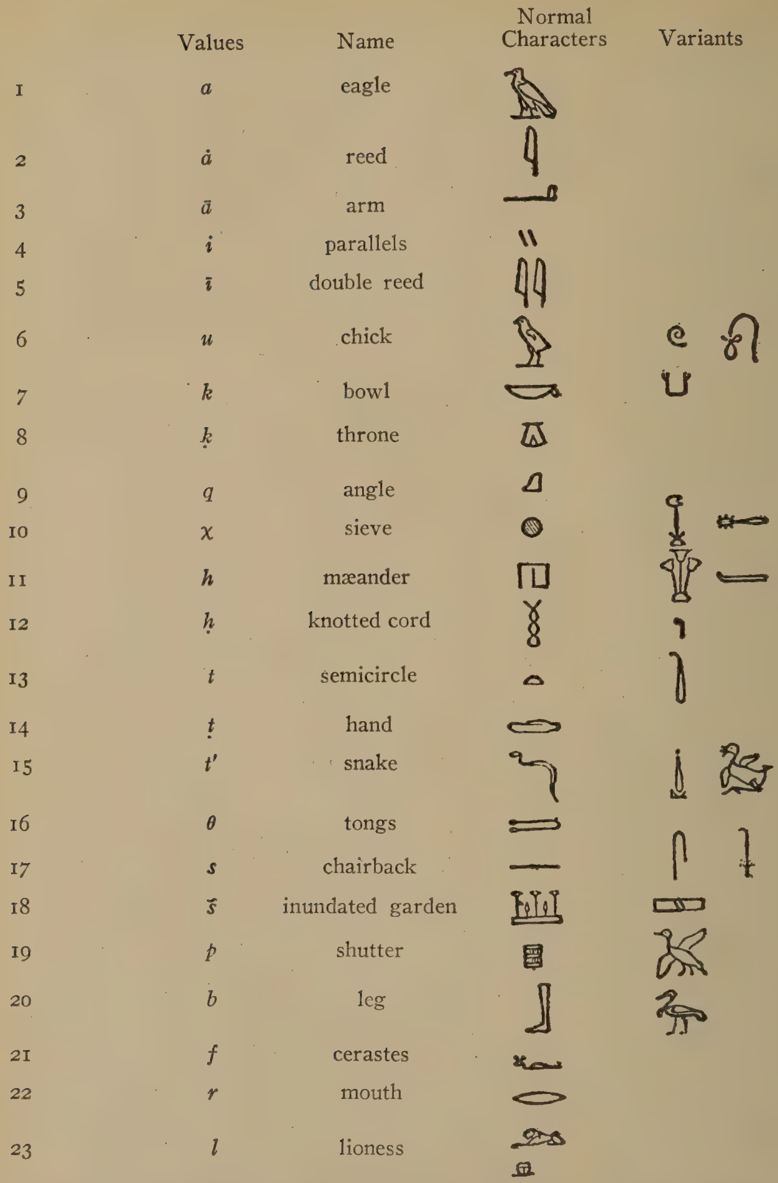


Figure 53. Origin and Evolution of the Letter M
(C. H. Judd, *The Psychology of Social Institutions,* The Macmillan Co., 1926)

Along with these changes in writing, we have the development of the modern languages with their many likenesses and some significant differences. Interesting as a study of these likenesses and differences is to the linguist, they do not contribute greatly to our genetic problem. Therefore, we shall



	Values	Name	Normal Characters	Variants
1	*a*	eagle		
2	*ȧ*	reed		
3	*ā*	arm		
4	*i*	parallels		
5	*ī*	double reed		
6	*u*	chick		
7	*k*	bowl		
8	*ḳ*	throne		
9	*q*	angle		
10	*χ*	sieve		
11	*h*	mæander		
12	*ḥ*	knotted cord		
13	*t*	semicircle		
14	*ṭ*	hand		
15	*t'*	snake		
16	*θ*	tongs		
17	*s*	chairback		
18	*š*	inundated garden		
19	*p*	shutter		
20	*b*	leg		
21	*f*	cerastes		
22	*r*	mouth		
23	*l*	lioness		

Figure 54. Egyptian Hieroglyphic Alphabet. (From Taylor's *The Alphabet*)

leave the phylogenetic problem of language and go to the ontogenetic problem.

How the Child Acquires a Language.—The development of the child's language differs in one important respect from the racial development of the language; the child has his language pattern already prepared for him. He has a problem of learning, but it is the learning of previously constructed system, not the invention of a new system of communication. Seemingly, the child sometimes resents the fact that originality is not commended and attempts to invent his own language. Such attempts may meet with approval if they do not go too far. It is rather common for two or more children to use sounds and conventionalize their meanings. These systems may become rather elaborate and extensive. But the child must also learn the language of his adult associates and use it in his ordinary conversations. "Ta ta" for thank you may be understood and rewarded in the young child, but "baby talk" either in the form of original expressions or faulty pronunciations of ordinary words is discouraged and discountenanced in the child of school age.

While language is artificial rather than natural, one of the child's very first acts is a vocalization—a cry. Some authors have tried to explain these early cries as an attempt at conversation; but if anything more than a purely reflex response, they are the expression of an emotion. Even this statement is probably entirely too anthropomorphic. Other early expressions consist in more crying, gurgles, and random vocalizations. Romanes[8] says one of his own children said "alla," "tata," "mama" and "papa." Preyer[9] says short "u" with a quickly following long Italian "a" was the first sound produced by his child. This came in the first few weeks of the child's life. The first consonant sound was "m." It appeared in the combination of "mama" on the forty-third day of the child's life. Other words which followed were "go," "ore," and "ara." True vocal laughter may have preceded some of these sounds but does not occur in the first few weeks. Miss Shinn's niece first said "ng" and "nga." As children grow older these vocalizations increase in number and complexity. There are truly random expressions. Even deaf children who know nothing of the value or significance of language make such sounds.

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[8] G. J. Romanes, *Mental Evolution in Man*, London, 1883, p. 122.
[9] Wm. Preyer, *The Development of the Intellect*, D. Appleton & Co., 1889, p. 101.

How does the child learn to use these sounds to express his thoughts? It is true that the child understands and obeys many commands before he speaks words. Furthermore, the extent of the understood vocabulary is always greater than the used vocabulary. This is evidence that the child gets the significance of speech before he uses it himself. However, the amount of this thinking probably closely follows the development of his spoken vocabulary. No very clear ideas precede the vocabulary to express them.

The child makes his cries as a result of pain and distress. He makes many other sounds as a form of random movement. Some of these sounds like "dada," "mama," "da," "ha," are similar to words for objects. When the child says "mama" quite by accident in the presence of his mother, he is likely to be petted and his behavior approved and rewarded in various ways. When he makes such sounds when his mother is not present, he is not so rewarded. By such means an association is formed between the sound "mama" and his mother. The child already has heard other people use the word "mama." The word spoken by others means mama to him. His new acquisition is the pronunciation of the word for himself. In a similar way other words are learned. Allport[10] believes that this is the way spoken language is acquired. Such an explanation will account for much of the learning to speak a language. However, it seems that the hearing of the words spoken by others somehow helps the child to produce the sound heard. Whether the speaking by another makes more ready the response in the child which produces a similar sound, is not clear. Somehow the use of words by others aids the child in learning to produce that word. Thorndike, who criticizes the popular notion of general imitation, admits the tendency to smile when others are smiling, to laugh when others are laughing, to yell when others yell, to jabber when others jabber, and to become silent when others are silent. Even such a conservative statement as this gives a basis for learning by observation or imitation. Trial and error alone is not enough.

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[10] Floyd H. Allport, *Social Psychology,* Houghton Mifflin Co., 1924.

The ability of the child to speak words generally begins the latter part of the first or during the second year. Several studies[11] have been made of the vocabularies of children of different ages. Two conditions tend to make the results for these studies higher than for average children. One reason is that most of the children studied were of more than average intelligence. The other limitation of such studies is the fact that most of them were made by parents or relatives. Verily, how difficult it is, however hard he may try, for the fond parent to be strictly unbiased in studying and reporting the responses of his children. The following table gives the average spoken vocabulary for different ages taken from several studies. This list includes only the uninflected form of each word and does not include proper nouns.

TABLE 6

Age in Years.....	1	1½	2	2½	3	4	5	6
Pelsma	10		379		681	1,278		
Nice		133			1,139	1,765	2,502	
Grant	3	30	121					3,075
Bohn	1	51	71					
Average of several reported by Nice.......					1,338	1,840		4,225

While there is considerable variation between the results for the different investigators and while they are all probably above the average for the population in general, yet this table does give some idea about the size of the spoken vocabulary of children.

Smith[12] by means of a vocabulary test, checked by comparison with actual word studies, gives the following average vocabularies for young children. It will be noted that these are not the number of words used by the child but the number which he is able to understand. This study was carried out with larger groups and presumably with more nearly average children than those reported in the former study. This, no doubt, accounts for the fact that the number of words understood by the child is not as great as the average numbers reported as used by the children in the former study. Certainly the number of words understood by a child is considerably larger than the number that he uses in conversation.

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[11] Studies. See Madorah E. Smith, *Iowa University Studies in Child Welfare*, 1927, Vol. III, No. 5, for an excellent bibliography including 29 vocabulary studies.

[12] *Ibid.*

TABLE 7. WORDS UNDERSTOOD BY CHILDREN OF DIFFERENT AGES

Age in Years ..	1	1½	2	2½	3	3½	4	4½	5	5½	6
No. of words...	3	22	272	446	896	1,222	1,540	1,870	2,072	2,289	2,562

Terman[13] in his study of intelligence gives the number of words which children and adults can define as follows:

TABLE 8. NUMBER OF WORDS CHILDREN AND ADULTS CAN DEFINE

Age in Years	8	10	12	14	16 (Average Adult)	18 (Superior Adult)
No. of words	3,600	5,400	7,200	9,000	11,700	13,500

It will also be interesting to compare these studies with another which gives the written vocabulary of children for different school grades. These are averages for about 150 pupils from each grade in four representative schools located in widely separated parts of the United States. They are supposedly average children. These results and Terman's should be directly comparable. If so, they seem to show that the written vocabulary is only about half as large as the vocabulary which the child understands.

TABLE 9. WRITTEN VOCABULARY OF CHILDREN

School Grade	2	3	4	5	6	7	8
No. of words.......	1,927	2,497	2,938	3,370	3,795	4,264	4,682

Several studies have been made of the relative frequency of different parts of speech for children of various ages. The following table gives the results obtained by three different investigators.

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[13] L. M. Terman, *The Measurement of Intelligence,* Houghton Mifflin Co., 1916, p. 226.

Table 10. Per Cents of Different Parts of Speech Used by Children of Various Ages

	1½ yrs.		2 yrs.	3 yrs.		4 yrs.		6 yrs.
	Nice[14]	Pelsma[15]	Grant[16]	Nice	Pelsma	Nice	Pelsma	Nice
Nouns	76	56	55	54	60	55	56	56
Verbs	7	23	30	21	21	21	20	21
Pronouns ..	0	2.7	.9	2.6	2	1.8	2	1.5
Adjectives and adverbs ..	12	10	11	18	14	19	17	19
Prepositions and conjunctions..	0	2	3.3	2.5	7.3	1.8	2.1	1.5
Others	3.7	1.6		1.6	1.1	1.2	1.3	1.9

While there are some variations in these, there is considerable general agreement. Nouns constitute more than half the vocabulary of the child. Verbs constitute about one-fifth. Pronouns average more than 2%, while adjectives and adverbs increase from about 10% to nearly 20%. Prepositions constitute about 2% more. These percentages are not greatly different from the per cents of different parts of speech as found in the dictionary. These are given as: nouns 60%, verbs 11%, adjectives and adverbs 27.5%, and all others, 1.5%.

There has been one other study concerning the language of the child of quite a different character. Piaget[17] made a very careful analysis of the language and thought of the child from age 6 to 11. In his preliminary study he took down the verbatim conversation of two children in a morning class at the Maison des Petits de l'institute Rousseau, Paris, for one month. He later studied in a similar manner the speech of a class of about twenty children in this same school. Some of his later studies included older children. He also varied his technique with the older children. To these he gave a series of ten proverbs such as "Little streams make mighty rivers," which were followed by twelve sentences, ten of which expressed the same idea as each of the ten proverbs but the sentences were arranged in a different order. The children were asked to fit the sentences to the proverbs which expressed essentially the same idea. In a still later study he investigated the questions asked spontaneously by children of different ages.

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[14] M. M. Nice, "The Speech Development of a Child from 18 Months to 6 Years," *Pedagogical Seminary and Journal of Genetic Psychology*, (1917) Vol. 24, pp. 204–243.

[15] J. R. Pelsma, "A Child's Vocabulary and Its Development," *Pedagogical Seminary, etc.*, (1910) Vol. 17, pp. 328–369.

[16] J. R. Grant, "A Child's Vocabulary and Its Growth," *Pedagogical Seminary, etc.*, (1915) Vol. 22, pp. 183–203.

[17] Jean Piaget, *The Language and Thought of the Child*, Harcourt, Brace & Co., 1926.

Upon the basis of these studies Piaget made a careful analysis of the language and modes of thought of the child. In this chapter we shall give something of his findings about language and in the following chapter something concerning the reasoning of the child.

Piaget believes that the mode of thought of the young child is quite different from the logical thinking of the adult. The child's thought is essentially what he calls ego-centric. This is a form in which conclusions are reached without the mediation of the steps of logical reasoning. It is the form most like that of the adult in day dreaming and invention.

Ego-centric logic is more intuitive and less explicit. There is no process of proving the items in the thinking process. Analogy is used extensively. Visual systems are set up as a basis for this type of thinking. For this reason it is very often impossible for the person to put his thoughts into word forms. Such are some of the characteristics of the thinking of children.

Along with these characteristics of thinking goes certain special language forms. These are classified under ego-centric and socialized speech. Ego-centric speech is further divided into (1) repetition, (2) monologue, and (3) dual or collective monologue. Socialized speech is divided into (4) adapted information, (5) criticism, (6) commands, requests, and threats, (7) questions, and (8) answers.

1. Repetition is the common form of speech of small children for the first two or three years. The child hears a word and begins to repeat the word, or he may hear a phrase or short sentence and repeat it. This repetition has no reference to other persons present. It is not used to convey thought. It is similar to what psychiatrists have called echolalia in insane patients. Piaget found from 1% to 5% of such speech in his two children of 6. Of course, as has been intimated, such speech is common in younger children and gradually decreases until it is almost gone by school age.

2. Monologue is another form of speech often used by children. In the monologue the child initiates speech. Piaget thinks that there is a close relationship between action and speech and the child is likely to talk while doing things. This talk like the first type is not for informing others but rather a spontaneous form of vocal activity which goes along with gross bodily activity. This form of speech constituted 5% to 15% of the two 6-year-old pupils.

3. Collective monologue is a form of talking in which the child is conscious of the presence of others but he is really talking to himself. The two children described in the first experiment go on talking but neither pays any attention to the other. It is partly social since the presence of the other child is an added stimulus for talking even if it is not intended that the other child listen. Collective monologue occupies 23% to 30% of the conversation of Piaget's two 6-year-old children.

Ego-centric language in all forms comprises a little less than half (45%) of the conversation of the two children studied. Other children studied later give similar results with a rather rapid decrease for higher ages. There is, of course, a corresponding increase in socialized language.

4. Adapted information is the simplest type of socialized language. In this type the child contrives to make his hearer listen and to tell him something. Such remarks as "Here let me show you," or "I think that goes here" are examples. Only about 13% of the 6-year-old's language is of this type.

5. Criticism requires comparison and a form of judgment not often found in children of six (3–7%).

6. Commands, requests, and threats do not require so much comparison and are more common (10–15%).

7 and 8. Questions and answers constitute 14% to 18% of the children's conversation. However, the form of the questions and answers show little interest in causal relations. This type of request or reply comes later in the life of the child.

This study of Piaget's is interesting and gives us insight into the language of the child. It is based upon an experimental study under partially controlled conditions. However, the results should not be taken too uncritically since there are certain apparent defects in technique several of which Piaget himself readily admits.

First, many of the conclusions are based upon a study of two children (later largely substantiated by a study of six older children). We do not know how typical they are. Not even the I. Q.'s are given. About twenty other children were studied but neither extensively or intensively. Neither do we know how typical they were of children in general. We do not know, for example, whether French and American children think in the same way.

Secondly, there is some question whether the language of the children during school, even though there was much freedom in the school where the study was made, is typical of the child's ordinary conversation.

Third, the quantitative data given are most meager. Mere averages are given with no presentation of the raw data or even any measures of the deviations. This is particularly significant because of the subjective character of the data.

Fourth, Piaget certainly might and it seems to some readers at least that he did *read into* what the child said his own interpretation of what the child meant. This is a rather extreme form of anthropomorphism.

These are not presented so much as criticisms as it is to make us critical and to wish for more conclusive proof or disproof of Piaget's conclusions. Let us now turn to another problem in the language of the child.

The child enters school at 5 or 6 years of age with a rather extensive and elaborate speaking vocabulary. The teacher's problem is that of substituting visual symbols for the already formed auditory symbols of the child. The next problem is that of short-circuiting by which the printed symbols directly call forth meanings. This may be illustrated as follows:

Until the last decade or two the method of teaching reading to beginners consisted in teaching them the alphabet first. What was more logical than to begin with the elements and then build up words from these elements? More recently it has been found more efficient to teach the child easy words which he knows first. Then later he can be taught the elements of which the word is composed. By teaching words, the child is directly introduced to material which he knows. This makes the reading meaningful and interesting. With a normal amount of assistance from the teacher, the child will by practice learn to read efficiently and rapidly. The material should be interesting, easy, and provided in large quantities.

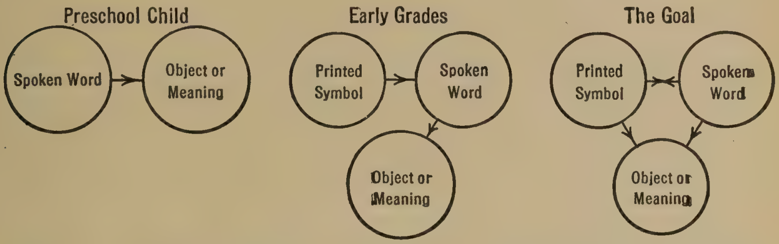

Figure 55. Illustrating How Children Learn the Relation Between the Object, the Spoken and the Printed Word

The early reading of the child is generally oral. This is as it should be. Just as soon as the mechanics of reading begins to become perfected, silent reading should be introduced. By the third or fourth grade, most of the child's reading should be for meaning and should be silent. Only enough oral reading should be required after this to check up on faulty habits and to prepare the child for the small amount of oral reading which he may have to do as an adult.

Two important factors are involved in rapid reading. One is the mechanics of eye movements and the other is the problem of meaning.

In his first reading the child makes many movements of his eyes back and forth over the words he is reading. At about the third grade the average child is able to read ordinary words with one fixation each.[18] If the child has average ability and is well taught beyond this stage, he develops rather regular habits of five or six fixations of two to three-tenths of a second each per line. When such skill is developed, reading takes place by phrases rather than by words. These phrases consist of single,

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[18] It may be worth while pointing out here that the eye does not move smoothly over the line but in a succession of jumps and pauses. Reading takes place only during the pauses or fixations, as they are called.

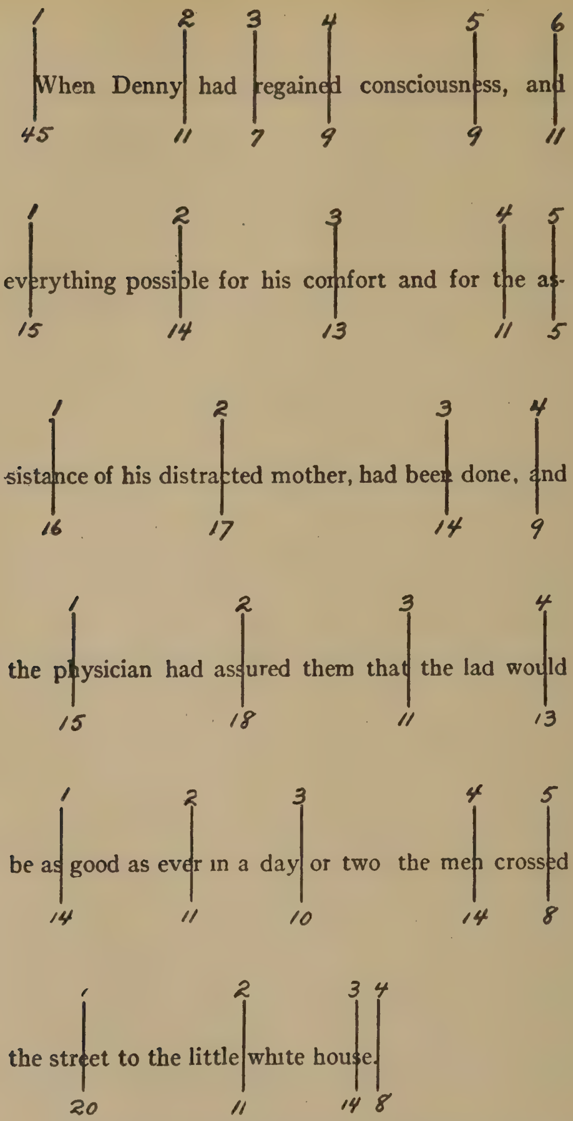
1 2 3 4 5 6
When Denny had regained consciousness, and
45 11 7 9 9 11
1 2 3 4 5
everything possible for his comfort and for the as-
15 14 13 11 5
1 2 3 4
sistance of his distracted mother, had been done, and
16 17 14 9
1 2 3 4
the physician had assured them that the lad would
15 18 11 13
1 2 3 4 5
be as good as ever in a day or two the men crossed
14 11 10 14 8
1 2 3 4
the street to the little white house.
20 11 14 8

Figure 56. Silent Reading by Subject A

The number above refers to the number of the fixation. The number underneath the lines gives the length of the fixations in fiftieths of a second.

(C. H. Judd *et al.*, *Reading: Its Nature and Development*, Department of Education, University of Chicago, 1918. This part of the study conducted by A. R. Gilliland.)

long, or difficult words, or of two or even three short words. Spacing of the words as well as the context modifies both the position and length of these fixations. What has just been said applies to silent reading. In oral reading the average reader seldom gets beyond the word reading habit. Vocalization slows down the reading process, and pronunciation emphasizes the word as the unit. In silent reading no such retarding factors are involved and more skill and speed are possible.

The other problem, that of the development of meanings, has already been mentioned. The young child gets his meanings through hearing words used in context or in asking parents or others what words mean. The older child may discover what words mean through the context in reading; he may ask his teacher; or he may look the word up in the dictionary.

Reading gradually ceases to be a routine process and becomes a method of acquiring knowledge. This comes through acquisition of meanings of words, but after a few thousand words are known it is the combination of these that conveys ideas. Even the most profound ideas may be expressed in simple words. Reading for the adult is of two main types: reading for entertainment and reading for information. While differing in purpose they do not differ greatly in method.

Writing.—Writing is another subject that occupies a large amount of the time of the child. Soon after he has learned to read, or even during the time he is learning, the child is being taught how to write. At first this may take the form of printing, or the child may be taught script from the start. There are two main factors in learning to write. The first is the comprehension of the form of letters. Interesting and important as this problem is, the general principles involved have been described in Chapter 9. Further practical consideration of this topic is rather a problem for educational psychology than for genetic psychology.

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CHAPTER 15

MEMORY AND THINKING

General Facts of Learning.—Learning is the general term used to denote any change in behavior due to experience. When used in its broadest sense learning is a characteristic of all matter. The nail that bends as it is driven into the board may be straightened but it will be very difficult to drive it further. In the bending and straightening an annealing process has taken place that makes the iron of the nail softer. The bending may be considered a process of learning. It is true that the nail really had nothing to do in the process. All the forces which affected the bending were forces applied to the nail from the outside. While this seems an essential difference between the action of the nail and learning in man a closer study of the problem may show the difference to be more apparent than real. Most if not all the forces which affect man and cause learning are either external forces or internal forces directly traceable to external ones.

It may be found that the principles involved in the bending of the nail are of the same kind and differ only in degree with learning of the so-called higher types. Plants are more susceptible to the modification of their behavior than most inanimate material. The limb of a tree may be bent by the wind. Thereafter not so much force will be needed to bend the limb. Animals are more easily influenced by their environment than plants. Even the one-celled animals like the amoeba are susceptible to changes in heat, light, certain chemicals, and to internal changes such as lack of food. It is true that such animals retain such modifications a very short time and are little able to profit by previous experience. However, there is a tendency in this direction which constitutes the essential basis for learning.

Characteristics of Learning.—The position of any species of animal in the animal scale may well be classified on the basis of their ability to learn. As we go up the animal scale we find greater and greater ability in *versatility* of response and to *profit* from previous experience. Man as the highest form of animal life manifests these capacities to the highest degree.

If learning is considered a characteristic of all matter we should distinguish those factors which make learning more possible in some forms of matter than in others. *Plasticity* is certainly one of those factors. It would be difficult if not impossible to modify iridium or a piece of granite in any way that could be considered as learning. It might be possible for the sake of argument to say that a minimal amount of change were possible but anything more than this would constitute an irreversible or permanent change in structure and this is not learning. Other substances that are more modifiable are more susceptible of change.

However, mere change is not enough. These changes must be *retained* in some way. Putty is modifiable but any impression made upon it is lost when another impression is made. The amoeba is changed by its environment but these changes are retained hardly long enough for it to be manifested in later behavior. As we progress in the animal series we find these two characteristics of learning exhibited in greater and greater degree. There is the further problem of whether these characteristics are a property of the animal as a whole or whether through specialization in structure and function special parts of the animal have been set apart for the specific function of learning. Most biologists and psychologists have considered the nervous system with its sensory and motor connections as the basis for learning. Although too narrow an interpretation of this view in a literal reflex arc form is untenable, when applied in a liberal way it explains the facts. Just how learning takes place we do not know. One of the most generally accepted views is that learning is a process of change in the synaptic resistance in neural pathways. As learning takes place the resistance of pathways is lowered. Thereafter nervous currents tend to pass over these pathways more readily than before.[1]

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[1] It must be admitted that the above account sounds much like the extreme reflex arc concept just criticized. The difference may at least be partially explained by saying that the above permits of an interpretation in the form of *patterns* rather than specific neural arcs.

The Nature of Memory.—Learning may be classified under two main heads: motor learning and memory. The first of these has already been considered in Chapter 10 under the title of the Acquisition of Skill. The second will be considered in the first section of this chapter. In this kind of learning which we are calling memory the material of the process may be either concrete or symbolic. Concrete memory is often called imagination. Symbolic memory is generally in the form of language. Memory may be further classified or analyzed in several ways.

Memory may be for shorter or longer periods. When the recall follows the learning after only a short interval, it is called immediate recall. If the time interval is longer, it is called delayed recall. Memory has sometimes been classified as intentional or unintentional depending upon the purpose or motive on the part of the learner. Memory has also been classified as productive or reproductive. If the material recalled is recalled in much the same way it was learned, that is, if it is a relatively true reproduction, it is called reproductive memory. If, on the other hand, the material is grouped into new combinations, that is, if new results are obtained, it is called productive memory. Such recall as the latter type, when it is motivated, is really thinking or reasoning and will be discussed in more detail in the latter part of this chapter.

Parts of the Memory Process.—Memory, while in reality a unitary process, for the sake of further study may be analyzed into three parts. These are: (1) memorizing[2] or imprinting, (2) retention, and (3) recall. Very often a fourth element called recognition is considered as a part of the memory process. It is not listed here since it refers to the degree of completeness of recall in relation to the learning. When recall is very incomplete and consists of little more than a "feeling of familiarity" it is called recognition. For example, we recognize having seen a person before but cannot recall the time or place of the previous meeting.

1. Memorizing is the initial part of the memory process. It is that part of the process in which the organism is modified

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[2] Memorizing is sometimes used in the narrower sense of rote memory. It is used in this chapter in the broader sense as the first step in memory.

by experience. It is therefore the part that is necessary before retention or recall is possible. Memorizing depends upon the factors enumerated in Chapter 10 as the basis of learning. Motivation is the basis of memorization. By strengthening through use, substitute stimulus, substitute response, and combination, new forms of stimuli come to be connected with new forms of behavior. By repetition or the law of use, disuse, and effect memorizing is strengthened or weakened. These are the factors which in connection with the innate capacity of the organism determines the extent of memorizing.

2. Retention consists in maintaining whatever has been memorized for a certain period of time. This time may be short or long. The length and strength of retention depends upon the effectiveness of the memorizing and upon the inherent retentiveness of the learner. These differ from one individual to another and for different ages in the same individual.

3. Recall is the reinstatement of some experience that has been learned. It is the final step in the memory process and is the measure or test of it. Recall depends upon memorizing, retention, and upon the appropriate stimulus for the recall. Recall will not come spontaneously. It comes only as the result of some present situation which by association calls up past experiences. It makes a great difference as to the form of the present situation. The stimulus may be in some form not so closely associated with the previous experience that recall will result. Who has not heard the child who failed to answer a question say after hearing the correct answer: "Oh was that what you wanted? I knew that all the time."

The stimulus for recall is not always a question or at least it is not always stated in question form. We see a person and recall having seen him before. One idea about which we have been thinking may recall another. Sometimes when little is demanding our attention, previous events crop up in our memories. This has sometimes, rather misleadingly, been called spontaneous recall.

Age Changes in the Memory Process.—One of the major genetic problems in memory is the age changes in each of the steps in the process. The first is the growth of memorizing ability. This problem has already been touched upon in the chapter on the Development of Perception. Attention span and perceptual growth are closely related to memorizing ability. There have been many other studies of the growth of such abilities. A summary of a few of these are given in the following table. The distinction between perceptual ability and memorizing ability in these studies is not clearly drawn.

TABLE 11. AGE DIFFERENCES IN MEMORIZING

Age in Years....	6	7	8	9	10	11	12	13	14	15	16	Adult
Digits:												
Auditory[3]......		5	5	5	6	6	6	6	6	6	6	7
Visual		5	5	6	6	6	7	7	7	7	7	7½
Concrete words[4].			32.0	32.5	37.7	37.7	38.4	39.0	42.1	41.1	43.0	46
Abstract words..			21.7	25.1	28.9	31.7	32.5	34.2	38.1	36.0	40.5	41.0
Pictures[5]	5.3	6.1	6.0	7.3	7.5	7.5	8.4	9.2	10.0			

These tables and the accompanying graph show consistent gains from the earliest age at which the studies were begun through adolescence to adult life. Such studies, however, do not furnish us much information concerning the real nature of the growth of memorizing.

Whether these differences are due to some type of maturation or to practice, we do not know. Other subtile factors such as interest and attention to details of instruction also tend to invalidate such results. However, with all these criticisms there is no doubt that the capacity to memorize increases with age up to post-adolescence and even to adult life.

Memory differs for different kinds of materials and is especially dependent upon the interests of the subjects. For example, children remember things that interest them, such as animals and games, better than they remember meaningless material such as a foreign vocabulary. Stern[6] summarizes this fact by saying that at about 7 years the child is primarily interested in *persons* and *things,* without coherent connection. From about the eighth to the eleventh year he is interested in *action.* In the next period, from 12 to 14, he is interested in *relations:* and, finally, from 14 onward, he is interested in qualities. This is only a statement of the common general interests of children of different ages. It also explains what they remember most

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[3] F. Smedley, *Chicago Public School Report*, No. 3 (1900–1901).

[4] W. H. Pyle, *Manual for the Mental and Physical Examination of School Children*, University of Missouri, 1920, p. 70 ff.

[5] D. F. Carpenter, *Journal of Educational Psychology*, (1913) Vol. IV, pp. 538–544.

[6] Wm. Stern, *Zur Psychologie der Aussage*.

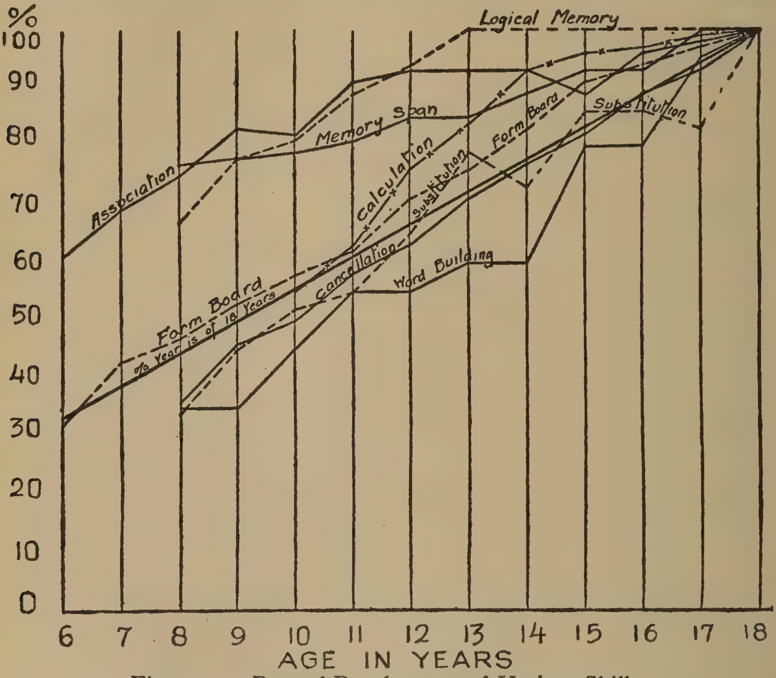

Figure 57. Rate of Development of Various Skills

From 6 to 18 years (in terms of the per cent of the 18-year record reached by each year).

(H. L. Hollingworth and A. T. Poffenberger, *Applied Psychology,* D. Appleton & Co., 1923)

easily during these years. The same facts have been brought out in another way by parts of the Stanford Revision of the Binet-Simon intelligence tests. In year 6 the typical definition of *chair* is "to sit on"; *horse,* "to ride on"; *fork,* "to eat with," etc. In year 8 the child defines a football as a leather ball to be kicked, a soldier as a man who fights, etc. In year 12 he defines pity, "to be sorry for some one in trouble," and charity, "to give help to the poor."

Children's Memory.—Some have contended that children differ greatly in the sense departments which they prefer to use in memorizing. It has also been claimed by some that these individuals use these same senses in recall. The first assumption may be true. Some people may have a preference, especially between visual and auditory presentation of material. However, the doctrine that we use the same sense department in recall has been proved false. We may learn material through one sense department and recall the material by another sense. Therefore, the old idea of imagery types has been exploded. Instead of being audiles, visuals, etc., most of us are partly one and partly another or sometimes one and sometimes another.

Retention is supposed to be greater in youth than in adult life. While the memorizing is more difficult, whatever is learned is retained longer. Many of us have vivid memories of things that happened in our youth. Some old people who can scarcely remember things which happened only a short time before repeat in detail events of their youth. At least part of the reason why material learned by the young is retained so well is the fact that so much effort and practice was necessary in the memorizing. It may also be true that there is greater retentivity in the nervous system in youth.

Thorndike[7] who has made a careful study of the problems of the rate of learning at different ages and the rate of deterioration in later life summarizes his results as follows. The general results of the studies of these problems indicate that there is a loss of about 15% from age 22 to 42 in sheer capacity to learn. This refers to the capacity to learn such material as is found in the ordinary college course. There is probably greater loss in the ability to learn such things as nonsense material. In material like that used by the average person in everyday life the loss is probably not as great as 15%. However, adults learn much less than they might, partly because they underestimate their ability and partly because of the unpleasant attention and comments they receive. If they really wanted to learn badly enough they could learn almost as well in middle life as at any earlier time.

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[7] E. L. Thorndike, *Adult Learning*, The Macmillan Co., 1928.

Methods of Measuring Memory.—Recall, as has already been said, is the measure of all the processes of memory. It also depends upon the form of the present stimulus. Since associations are so definitely dependent upon experience, the child is more limited in his recall than older persons. If the stimulus for recall is in the form of a question, it may assume any of several possible forms. (1) The question may take the form of a direct request for as complete a recall as possible without any further cues as to its character. "Repeat the first line of Longfellow's *Psalm of Life*" would be an example of this form which is called *direct recall.* (2) Another method is to determine the *time saved* in relearning the material. If the material is fully remembered no time will be required in relearning and the total learning time will be saved. If the material is partly forgotten the time for relearning will be shorter than the original learning time. That is, a certain amount of time will be saved and the amount will depend upon the degree of retention of the material that has been learned. (3) A method often used especially in experimental studies in learning nonsense syllables is by *paired associates.* One of the pair as learned is presented and the other of the pair is called for. There are also other methods such as (4) the *prompting method* and (5) the *recognition method* as well as other less common forms.

Thinking

The Relation of Memory to Thinking.—Memory, as the term has been used in this chapter, refers to the recall of material which has previously been experienced. It is a relatively true reproduction of the past. This is a very valuable attainment. There is another type of reinstatement of the past in which the parts are combined into new configurations. When it is directed toward solving a problem, it is called thinking or reasoning.

Thinking Variously Defined.—Thinking or reasoning is generally considered the highest type of mental process. Yet many different things go by the name of thinking. Dewey[8] mentions four different things which are called thinking. (1) Anything which "goes through the mind." Reverie and day-dreaming come under this heading. Or we may meet a friend and say, "Why, I was just thinking of you." (2) Whenever we do not directly sense anything, we may say we think so, meaning thereby that we believe it to be true. For example, we may say, "I think we should take this road." (3) We may accept something as reasonably probable or improbable. A man may say, "I think that my actions were appropriate in that situation." (4) The last and really true sense in which we may use the word is in the sense of an active persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and further conclusions to which it tends.

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[8] John Dewey, *How We Think*, D. C. Heath & Co., 1910.

Materials of Thinking.—As was pointed out in the last chapter, language is the common tool by which thinking takes place, although it does not always take place in this form. Whatever thinking the lower animal does is in terms of concrete situations. The young child also thinks largely in the concrete.

Gates[9] mentions five different forms in which thinking may take place. These are (1) in the form of images of "pictures in the mind's eye." Galton's famous study of how different people recalled their breakfast table showed that there were many differences in the way people recalled the situation. One of the most common was the "seeing" of the table and its furnishings. Some could "hear" the clinking of the dishes, "smell" the coffee, and "taste" the food.

2. Thinking may take the form of speaking words. Much thinking is done in terms of talking to oneself. Indeed, it has been found experimentally[10] that there are actual movements of the throat muscles during thought. This is probably not universally true of all people nor even of the same person at all times, but it has been found true in many cases.

3. Thinking may take the form of images of words. These verbal images may be visual, auditory, or kinaesthetic: that is, the person may see the words, hear them, or "feel" them. This

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[9] A. I. Gates, *Experimental Psychology* (rev. ed.) The Macmillan Co., 1928.

[10] Ruth Clark, "An Experimental Study of Silent Thinking," *Archives of Psychology*, Vol. XLVIII.

type of verbal imagery is to be distinguished from concrete imagery of the object or relation rather than the name for it.

4. Thinking may take the form of symbolic imagery. Of course, all forms of verbal imagery are symbolic. By the term as here used is meant symbolism other than language. Titchener[11] describes in some detail how he recalls certain outlines and classifications in terms of form and color. These are as vivid as they seem fantastic to some of us. Mathematical symbols are another form of such symbolism. It seems that some people work out rather elaborate symbolisms which they use in their thinking.

5. Thinking may take the form of movements without imagery. By this is meant that body sets and attitudes form the basis for some of our thinking. It is the writer's belief that much of our thinking goes on in this form. Certain relations are certainly generally thought of in this way. The recall of emotions may be in this form. Even if language is used in thinking, it is often slurred and deleted to a sort of skeleton. The feeling between the words of this skeleton is often in terms of sets or attitudes, generally kinaesthetic in character.

Gates suggests that there may be another type in which there is no imagery. In this, thought takes place in pure form without any carrier. This is called "imageless thought." Imageless thought has caused much controversy in psychology. However, we will not take up this topic further than the mere mention of the problem as has already been done.

The Forms of Thinking.—We may classify the forms of thinking under three headings: (1) trial and error thinking, (2) logical thinking, (3) consecutive, or what is often called scientific thinking.

1. Trial and error thinking is the most common and least efficient type. It consists essentially in arriving at some generalization in a hit or miss fashion. The child's first classification of objects into classes and his appreciation of qualities is a simple beginning in the process of such analysis. In fact, even the lower animals so classify objects and things. Concepts are gen-

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[11] E. B. Titchener, *Lectures on Experimental Psychology of the Thought Processes*, The Macmillan Co., 1909, pp. 1–101.

eralizations. The quality of whiteness is an abstraction. It is not until this process is extended to more difficult problems that it is called thinking, but the process is not essentially different. Hull[12] used Chinese characters to study experimentally how we generalize. Lists of characters were arranged in columns. All the characters in a column had some common element in them. Hull's problem was to find out how students could utilize these common factors in learning the series.

The really clever individual is the one who can see relationships and principles where others do not. The inventor sees a principle and devises an apparatus to meet the need. In this type of thinking the problem is accidental rather than deliberate. This distinguishes the first from the third form of thinking.

2. The second form is called logical thinking. This is not because the other two forms violate the principles of logic, but because in this form the thinking follows the formal steps of the syllogism. It consists of a major premise, a minor premise, and a conclusion. The classical illustration is:—

> All men are mortal.
> Socrates was a man.
> Therefore, Socrates was mortal.

There are several different forms of the syllogism, but they all contain these three parts. It is needless to say that very little of our thought takes this form. Only after we have done much thinking on a problem are we prepared to formulate it in such exact terms as the syllogism.

3. The third form, consecutive or scientific thinking, is the one which Dewey describes in detail. Thinking, he says, involves (1) a certain fund or store of experiences and facts from which suggestions proceed, (2) promptness, flexibility, and fertility of suggestions, and (3) orderliness, consecutiveness, appropriateness in what is suggested.

Factors in Good or Poor Thinking.—Much of our thinking is defective because of a violation of the first point. This is one of the chief sources of difficulty in children's thinking. They do not have a wide enough store of facts with which to compare their new problem. The adult has many ready-made categories into which the new problem may be put, hence it is classified, and the solution is immediate. The geologist looks at a shell and immediately classifies it as a shell of a trilobite. This has both advantages and dangers. It facilitates the solution of many questions. We refer the question to an expert and he solves it on the basis of his knowledge. Sometimes there is a "halo" projected about the expert and he is expected to solve all kinds of problems. There are interesting cases of men who have made a reputation for themselves in one field who try to extend their ability to other fields. For example, a few years ago one of our most prominent inventors attempted to construct an intelligence test. The result was a distinct failure. This man did not know the technique required for the construction of a mental test. Too often we see examples of men who have made a success in business but without other specific qualifications trying to fill governmental positions. We will have a better government when we prepare men specifically with information in governmental duties for political appointments.

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[12] C. L. Hull, "Quantitative Aspects of the Evolution of Concepts," *Psychological Monographs,* (1920) Vol. XXVIII, No. 123.

The second requirement of thinking really depends upon intelligence. It is the ability to see relationships and possibilities in the data at hand as well as the ability to see the need of further data before a solution is reached. This is partly a matter of innate ability and partly a matter of training. There must be a capacity present, but habits of flexibility and versatility are also matters of training. Children are not so versatile as adults. If they have ability and are well trained they will develop into capable thinkers. There is no royal road to this destination, but there are many important guideposts along the path.

The third factor is even more a result of the development of correct habits of thinking. There are certain general rules, which will be discussed later, that govern correct thinking. Here is where a good teacher becomes an important factor. Although the subject matter may be different, the general methods of correct thinking are very similar in all subjects. The child is fortunate who learns these methods early in life.

Steps in the Thinking Process.—Pearson[13] has named five steps in the scientific method. They are: (1) the collection of facts or data, (2) the classification of the data, (3) the formulation of a theory, (4) the setting up of an experiment to test the theory, and (5) the formulation of a principle or law. These five correspond closely with Dewey's five steps in reflection. Dewey's five steps are: (1) a felt difficulty, (2) its location and definition, (3) the suggestion of a possible solution, (4) development by reasoning of the bearings of the suggestion on the problem at hand, and (5) further observation and experiment leading to its acceptance or rejection, i.e., the conclusion in belief or disbelief. We have given both the steps in the scientific method and in thinking. The scientific method represents just one very important type of thinking. It differs from ordinary thinking or reasoning in that in science the theory is put to an experimentally controlled test. In thinking we test our hypothesis by weighing the facts or, as we may say, by testing them by mental trial and error.

Through a failure to fulfill each of the five steps in thinking, the child does not do much serious thinking. This is less true of the first step—realizing a felt difficulty—than of any of the others. The child is constantly locating difficulties and problems. He is incessantly asking "What," "Where," "How," and "Why" questions. Whether these are manifestations of an instinct of curiosity or not makes little difference in our present discussion. They do give evidence of a desire to know, a desire which should not be thwarted by busy or irritable parents or teachers. This desire may be very vague, but this is not a difficulty if the urge is strong enough to lead to the second step. Here the unguided child has difficulty. He cannot locate and define his problem. There is considerable truth in the saying that to state a problem is to half solve it. But to state a problem clearly is a very difficult task. It necessitates familiarity, insight, and versatility which come only as a result of experience and training.

The third step follows directly from the second step. When the problem has been defined, the possible solutions are limited.

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[13] Karl Pearson, *Grammar of Science,* The Macmillan Co., 1911.

Many facts can be clearly seen not to apply. The problem resolves itself into a few possible solutions. Intelligence is the one large factor in this step. The intelligent individual can see the implications and possibilities of the problem. The less intelligent individual cannot.

In step four the only real difference between the scientific method and ordinary reasoning is that in the scientific method the proposition must be put to the experimental test by controlling the conditions and measuring the results. In reasoning we try out the possible solution or hypotheses by the association of ideas. Many times this is all we can do. Many problems are not susceptible to experimentation. Darwin could not test his origin of species hypothesis by experimental technique. Without in any way discrediting the scientific method, we must realize that it has its limitations and that much of our thinking may not be scientific and yet be true and accurate.

The last step leads to the conclusion or, in technical terms, to the judgment. This conclusion inevitably follows if our other steps have been correct. The child develops a stock of information. He sorts this in each particular case to find out what applies to the problem at hand. He applies his wider knowledge. He decides the possibilities in the case. Then he tries these out to find which if any is the correct one. All this takes time. The adolescent does not suddenly develop the ability to think. The smartest child can think in a very simple way. As he grows older his ability grows. Good training aids in the process.

We must keep it in mind that no adult spends a great part of his time in thinking. We are largely creatures of innate tendencies and habits. Only the keenest and most active men do much real thinking, and they only part of the time. Yet it is upon these geniuses that the world must depend for enlightenment and progress. The rest of us play our parts, and they are important parts, but they consist largely in following—in carrying out the ideas of others.

Piaget's Study of the Thinking Processes of the Child.—In the preceding chapter mention was made of the study of the language of the child by Jean Piaget.[14] In connection with his study of language it was there noted that he also investigated the thought processes of children. By the same general methods used for the study of language, Piaget attempted to understand how the child thinks and reasons. His principal method of investigation was by studying the subordinate clauses (because clauses) used by the child, the answers the children give to such problems as Binet's Test: "I have three brothers, Paul, Ernest, and myself. What is foolish or silly about this?" and the definition given by children to such words as country, family, uncle, etc.

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[14] Jean Piaget, *Judgment and Reasoning in the Child,* Harcourt, Brace & Co., 1928.

Upon the basis of the analysis of the conversation of children and definitions, Piaget believes that children do not reason before the age 11 to 12. Before this age their thinking is characterized by what he calls (1) ego-centrism, (2) juxtaposition, and (3) syncretism. These terms will now be explained in more detail.

Ego-centrism is used to describe both the thinking and the language in which thought is expressed. As we have already seen, ego-centrism decreases as the child grows older. Along with the decrease of ego-centrism there is an increase in the "because" clauses used by the child. The following table gives these changes from years 3 to 7.

TABLE 12

No. of Children Studied	Age	Because Clauses	Per cent of Ego-centrism
2	3	1.2 to 1.5	56
1	4	1.2	60
1	5	2.0	46
2	6	2.0 and 2.4	43 and 47
2	7	3.5 and 6.1	27 and 30

Ego-centrism is due to the fact that the child has his own explanation for things as he finds them. G. Stanley Hall found that the child has many peculiar notions about things: Butter comes from buttercups. Thunder is God speaking, etc. God or man made the lakes and rivers by digging them out of the ground. These explanations Piaget says are real to the child. Only as he comes in contact with other people does the child find the necessity for logical explanations. This comes about gradually and does not arrive before the age of 11 or 12.

By juxtaposition Piaget means that the child's perceptions and ideas are jumbled. The different parts are thrown together in irregular order. There is no sequence—there is no hierarchy of ideas, as he expresses it. This condition is illustrated when the child tries to describe an object or event. He makes a series of discrete, unarranged statements. If there are conjunctions used they are generally "and," or some other coordinate conjunction. Few causal or other subordinate clauses are used. In fact, the child of 9 or below is not much concerned with causes and therefore does not use complex sentences.

Juxtaposition is illustrated by the child's attempt to answer the following questions: if an animal has long ears it is a mule or a donkey; if it has a thick tail it is a mule or a horse; this animal has long ears and a thick tail, what is it? The typical childish answer is: it may be any one of these animals. He does not analyze the situation, he just adds the parts together. The same principle is illustrated in his arithmetic. Given a simple problem of what is 5 times as much as 10 he may add, subtract, multiply, or divide. The capacity to weigh the elements of the problem has not yet developed.

What Piaget means by syncretism is more difficult to understand. It is a "schema" of perception before a true one is built up by experience. It is "wide and comprehensive but obscure and inaccurate." In it "no distinction is made and things are heaped one upon another." In language this is expressed by the fact that sentences exist for the child before the separate words. In thought, schema exist first and analysis comes later to correct and complete them.

This is further illustrated by one of the children's answers to why the moon does not fall down. The reasons given are: because it is high; because there is no sun; because the moon is high up. These facts constitute an indivisible idea, since they are always perceived together by the child.

Now it seems difficult to differentiate syncretism from egocentrism and juxtaposition. In fact, syncretism includes both of these, it being the comprehensive term which summarizes the views of Piaget, Claparede, and other French writers concerning the way in which the child views life and the way he explains things and events.

In fact, this view extends beyond an explanation of children's ideas. Levy-Bruhl gives a similar description of the thinking of primitive peoples. Freud's description of autistic thinking (day dreaming) and Blondel's account of morbid consciousness are of a similar character. How shall we accept such explanations of the way the child thinks? Some cautions to a too uncritical acceptance of Piaget's explanations were given in the preceding chapter. There are two or three other serious problems that may be raised despite the fact that several valuable contributions have been made by this study.

Dewey's description of the way we think helps us to formulate one of these criticisms. Despite Piaget's contention, the child of 5 or 8 does some very clear reasoning at times. In fields in which he has had experience, he can think very clearly and pointedly. In other fields his thinking is halting and uncritical. There is no one age at which he begins to think. Such a view considers thinking by chronological cross-sections. The point of view here defended is that thinking is in longitudinal sections. In things within the child's experience, he has the tools and at least the rudiments of the technique of thinking at a very early age. This tendency is even manifested in the development of his perceptions. In other fields or in problems of techniques beyond his experience, his reasoning is faulty. The adult is in much the same difficulty in similar circumstances. He, too, cannot reason in fields with which he is not familiar. The one great difference is that the normal adult has had so many experiences and in such a wide variety of fields that he is better prepared than the child in almost any field. The child gradually by experience develops both provinces of knowledge and methods of correct thinking.

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CHAPTER 16

THE EMOTIONS

Conflicting Opinions Concerning Emotions.—There is probably less agreement among writers on the subject of emotions than any other topic, unless it be the related topic of instincts. There is no common agreement on what constitutes a definition or description of an emotion or on the physiological bases of emotions. Many terms such as feelings, sentiments, affective states, and the like are used in relation to the emotions. The lack of common agreement also holds in regard to these related topics.

One reason for this confusion is the fact that most of the material found in textbooks is based upon theory rather than experimental data. However, this situation is gradually being improved. The work of Watson,[1] the Shermans,[2] Cannon,[3] Landis,[4] and others is gradually building up a substantial amount of verified knowledge on the subject of emotions.

Experimental Studies of the Emotions.—It was Cannon who first firmly established the physiological basis of the emotions. He found that, just as the central nervous system is the conductor of impulses and the striped muscles the movers in reflexes, instincts, and voluntary movements, so the autonomic nervous system is the conductor and the unstriped muscles and glands the primary movers in the emotions. There are two sensory approaches to the autonomic nervous system. One is indirect, through the sense organs and peripheral nerves of the central system from which branches extend to the autonomic

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[1] J. B. Watson and J. J. B. Morgan, "Emotional Reactions and Psychological Experimentation," *American Journal of Psychology,* (1917) Vol. 28, pp. 163–174.

[2] M. Sherman and I. C. Sherman, *The Process of Human Behavior,* W. W. Norton & Co., 1929.

[3] W. B. Cannon, *Bodily Changes in Pain, Hunger, Fear, and Rage,* D. Appleton & Co., 1929.

[4] Carney Landis, "Studies in Emotional Reactions," *Journal of Experimental Psychology,* (1924) Vol. 7, pp. 325–341 (and others).

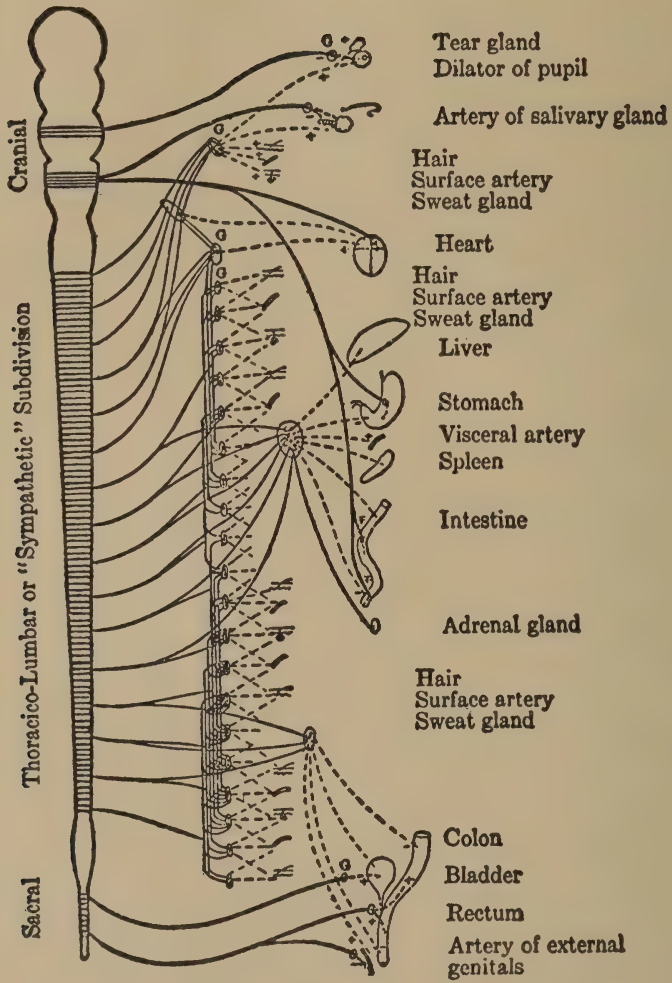

Figure 58. Diagram of the Autonomic Nervous System

The sympathetic division connects with all the organs; the cranial with organs in the upper part of the body; the sacral in the lower. (From Cannon, *American Journal of Psychology*, Vol. 25, p. 257.)

system. The other is from sensory endings of autonomic fibers in the viscera. These latter endings, of course, are not directly stimulable but are stimulated by movements of the viscera. (See Figure 58).

Functions of the Autonomic Nervous System.—The autonomic nervous system is, therefore, semi-independent of the central nervous system. Some of the impulses it receives directly from the central fibers. Others come through its own sense organs and sensory fibers. In a similar manner it sends impulses over its own motor system and it also sends impulses into the central system. The main bulk of the autonomic system consists of ganglia. The ganglia lie for the most part within the visceral cavity next to the spinal column. There are also other ganglia located in various parts of the body. For example, there is one in the heart and another in the pit of the stomach. Unlike the central nervous system in which the main bulk of the system is concentrated in a brain and spinal cord, the ganglia of the autonomic system are widely distributed and only loosely connected by means of the commisural fibers extending between the various ganglia.

The autonomic nervous system is divided into three parts (see Figure 59), each with separate functions. The following table gives some of the chief functions of each part.

TABLE 13. SOME COMMON FUNCTIONS OF THE AUTONOMIC NERVOUS SYSTEM

CRANIAL SEGMENT:
- Secretion of saliva and gastric juices.
- Narrowing of pupil of the eye.
- Slowing of heartbeats.
- Accelerating peristalsis.

SYMPATHETIC SEGMENT:
- Dilating pupil of eye.
- Accelerating heart action.
- Relaxing rectal and bladder muscles.
- Stimulating adrenal glands.

SACRAL SEGMENT:
- Expulsion of waste matter from rectum and bladder.
- Sex activity.

While much of this information was known before Cannon began his work, it was he who verified and extended this information. By carefully controlling the factors involved he was able to study what activity takes place in fear, for example. The heart is accelerated, peristalsis is stopped, breathing is shallow and labored. The pupils are distended and the eyes opened wide. Adrenalin is secreted by the adrenal gland. The hormone secreted by this gland is carried by the blood to all parts of the body and acts as a strong stimulant. Greater muscular strength is possible because of the liberation of stored food in the muscle fibers. The blood coagulates more readily because of the presence of adrenalin in it. All these activities are primarily the result of nervous impulses coming from the sympathetic seg-

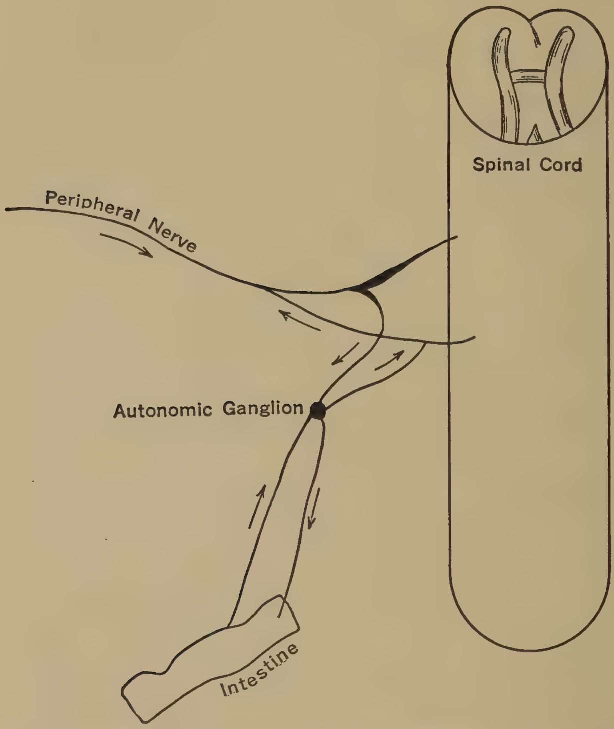

Figure 59. Showing Sensory and Motor Connections of the Autonomic Nervous System

There is a sensory and a motor connection with the central system. There is also a sensory and a motor connection with the viscera.

ment of the autonomic system. Very similar activities occur from stimuli which cause anger. No very clear-cut distinctions can be found to account for the difference between these emotions. Cannon believes that when the sympathetic division of the autonomic system functions it acts as a whole. This may not prove to be true. There may be a difference in pattern not yet discovered between the various emotions. In the two emotions just mentioned at least the organism is set for attack or for withdrawal respectively. This is a real distinction and may be found to constitute the essential difference between the two emotions.

In pleasurable activities such as eating palatable foods, the saliva is secreted in more than ordinary amounts. As the food reaches the stomach, gastric and other juices are secreted, peristalsis is increased and the body is in a generally relaxed condition. This condition is controlled by the cranial segment of the autonomic system, and the emotion is pleasantly toned.

In defecation, micturition, and sexual activity a tonic condition of the striped muscles of the pelvic region exists. In sexual activity the heart is stimulated and peristalsis is retarded. While there is some overlapping with other segments, the sacral is primarily involved in these acts. These are ordinarily pleasurable acts.

In this very brief and incomplete account of some of the common emotions we have given a clue to the physiological basis of the emotions. The cranial segment is the great conserver of bodily resources. The sacral has to do with a group of mechanisms for emptying. While different, these two divisions produce generally pleasurable responses. The sympathetic segment is opposed in action to both the cranial and sacral divisions. It is the great energy-producing agency of the body. The usual effects of its activity are displeasurable.

It will be noted from the discussion of these emotions that while the autonomic system is the chief agent for the activity, the central nervous system is also brought into action. In fact, it is probable that in almost any activity both the central and the autonomic systems are concerned. In some types such as reflexes and thinking, the central is primarily active. In other types, which we call the feelings and the emotions, the autonomic is primarily active. But these distinctions are differences in degree only. In other words, while the core of the emotion may be thought of as the activity of the unstriped muscles and glands of the body which are brought into action through the functioning of the autonomic system, there is always more or less activity in the striped muscles. For example, in fear peristalsis decreases or stops, the heart beat is accelerated, and adrenalin is secreted into the blood stream. There are also various facial and gross bodily movements. Vocal expression in the form of a cry or yell often accompanies the other forms of response. These are all fused into a behavior pattern which we call fear.

There is an important theoretical problem involved here as to whether the activity of a certain segment of the autonomic system, with the accompanying activity of the associated muscles and glands, *constitutes the emotion* or whether they are *concomitant with or precursors of the emotion.* This is, as yet, an unanswered question. No amount of argument on either side of this controversy is likely to convince those holding the opposite view. Therefore, without presenting arguments on either side, it will be dismissed as one of the problems for solution at some future time.

The Genesis of the Emotions.—After this consideration of the general problems of emotion, let us now turn to the genetic problems. Out of what nexus of infant behavior does the emotional life of the adult emerge? The Shermans, to whom reference has already been made, have given us some valuable information on this question. They took moving pictures of infants when responding to four different types of stimuli. These were: (1) hunger, (2) sudden dropping through space (fear), (3) restraint of the head and face (anger), and (4) pricking with a needle. The stimuli were carefully deleted from the pictures and the pictures were shown to graduate students[5] in psychology for the identification of the emotion. Nine different emotions were named for these four types of responses. For the hunger reaction, out of 32 observers 13 named the emotion as anger, 7 as hunger, 7 as fear, 3 as pain, and so on. To the fear stimulus 15 named anger, 5 fear, 6 hunger, and 3 pain. To the anger stimulus, 16 named the emotion correctly, 5 named it fear, 2 hunger, 4 pain, 2 discomfort, and 1 sleepiness. This shows how impossible it was to judge emotions of infants from behavior alone.

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[5] Nurses and medical students were also used in the experiment but did no better than the students in psychology.

Another group of students were told that there were only four emotions represented in the pictures and these were named. Even under these circumstances the ability to name the correct emotion was only slightly improved.

The authors say

> The infant even as old as six months does not show typical forms of behavior which can be characterized as definite emotions, but only generally aimless responses which can at most be called vaguely adaptive. It is only after the child begins to have knowledge of the social significance of his behavior that any of his responses can be named as definitely emotional.[6]

While there is much truth in this statement, it may overstate the case. First, reasonable as it may appear to be, there is no proof that all emotions evolve from a single simple undifferentiated origin. The fact that graduate students in psychology could not distinguish from a 16 mm. movie film what emotion the child was portraying does not prove that there was no difference. It only proves that the students couldn't tell the difference. The results might have been quite different if the mothers had been asked to interpret the babies' actual responses. Maybe even the mothers could not have guessed the correct emotion. The only point here is that, interesting and important as this experiment was, it does not prove the common origin of all emotions nor does it disprove it either.

Watson, working with newborn infants in a foundling hospital, upon the basis of extensive study, believes that there are three primary emotions, fear, love, and rage. Of course, Watson knew the stimulus to which the infants were subjected and, therefore, may have been influenced by this knowledge in making his classification. It is significant that Watson's list is much shorter than the earlier traditional list of human emotions.

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[6] Sherman and Sherman, *op. cit.*, p. 123.

Emotional Conditioning.—Of course, the emotions of the adult are not a simple undifferentiated response, nor are they the three simple emotions of the infant as listed by Watson. There are many kinds and degrees of fears. Many things which originally did not produce fear come to be stimuli for fear. Watson, for example, found only two stimuli adequate to produce fear in the infant—loud sounds, and lack of support. He studied how, by conditioning, the child could be taught to fear a rabbit. When the rabbit was first brought before the child, it put out its hand to touch the rabbit. Just as it touched the rabbit a loud noise was produced behind the child. This was repeated several times, and each time the child withdrew its hand and cried. Finally the child would withdraw its hand and begin crying whenever the rabbit was brought near.

It is in this way that children and adults learn to be afraid of other things than loud sounds and loss of support. The child in this way, by stories, by example, and by experience comes to fear the dark, goblins, snakes, dogs, cats, toads, fire, rapidly moving objects, and a host of other things.

There is also a modification in the way the child and adult behave toward fearful objects. At first, the child withdraws, cries, and possibly such actions are likely to bring mother. If so, in that way they are effective. But this form of behavior is not so effective as running away when the child learns to walk. Therefore, running is a common form of response often accompanied by crying. If the fright is extreme, paralysis may result. It is unnecessary to elaborate further. Every one can extend the list of responses from his own experiences. These may all be looked upon as substitute responses to fear stimuli. Thus we see how by both substitute stimuli and substitute responses the fear reactions of adults are built up.

Food and petting are normal stimuli for love responses in the child. The usual response is a relaxed state of the body with up and down movements of the arms and legs, generally accompanied by gurgling and cooing. As in the case of fear the love reactions are elaborated by learning of both the substitute stimulus and substitute response types. One of the earliest and easiest substitutes is love for the person ministering the food.

Mother love is no mysterious or innate affair. If the child never sees its parents there will be no more love for the parent than for any other person. Sometimes, therefore, if the child is bottle-fed it is the nurse rather than the parent that is loved. The earliest loves are not sexual in character, Freud to the contrary notwithstanding. However, sex stimulation gives pleasure and becomes a large factor in love responses. It is, of course, not until the development of sexual maturity or adolescence that the full effect and extent of sex influences become evident.

Due to social restrictions and customs, the forms of love response are indirect and elaborate. Courtship is only one form of such expression. Since this type of love depends upon the social situation there are many cases in which the love response is thwarted. This results in repressions and all kinds of substitutions. This topic will be discussed in more detail in a later part of this chapter.

The common stimulus for rage is physical hindrance to activity. All that is necessary to induce rage in an infant is to hold it so that it cannot move freely. Even the hindrance of clothes may produce rage. We may say that hindrance, physical or mental, is the common and almost universal cause for rage in both children and adults. The chief difference is that in adults there has been a great elaboration of the physical and mental causes which produce rage.

The infant cries when it is hungry. This may be sufficient to secure for it some relief from the cause which produced the crying for a while Sometimes it will not. It will then try other kinds of responses. It may lie on the floor and kick and squeal. Such behavior is called a temper tantrum. Mother may become alarmed at this point and pick the child up. It has succeeded in gaining a desirable result and thereafter it is likely to develop more temper tantrums.

A teacher recently told the following story. A boy about 5 years old, the son of wealthy parents, was brought to a private school by two nurses. Two nurses were necessary as it was impossible for either alone to manage him. Upon being brought into the schoolroom the boy flung himself upon the floor and began to yell and kick with all his might. The nurses began to pick him up but the teacher told them to leave him alone and pay no attention to him. The nurses were surprised and were certain that he would disrupt the whole school. Of course, the boy did disturb some of the other children, but he was even more disturbed when he found that no one was paying any attention to his tantrum. He cried for some time but finally got up and began to watch what the other children were doing. The next day he tried the same method as the first day but upon finding that it did not accomplish the desired end, he got up and after watching for a while finally entered into some of the activities with the other children. Within a week the temper tantrums had disappeared and the boy was beginning to adjust himself to the life of the school in a wholesome, energetic fashion.

It is not to be inferred from this discussion that there is no place in life for rage. The man who never gets angry never contributes much to the world. He should be angry at wrong, crime, laziness, and at both sins of omission and commission. The great trouble with most of us is that we develop a rage at the wrong things in life and are not enraged at the things that should arouse our anger.

Lists of Emotions.—Is this the end of our list of emotions? Some authors say yes. Some others like McDougall say no. How about "joy," "grief," "mirth," "ecstasy," "restiveness," "exuberance," "wonder," "disgust," "detestation," "timidity," "shame," "awe," "tenderness," "coyness," "lust," "jealousy," "pride," "dread," "remorse," "anxiety," etc.? Are all these emotions? It makes little difference whether we call them such or not. Whether they all develop from one common core as the Shermans believe, or from three basal emotions as Watson holds, or from these three and one or two more we cannot be sure. It it certain, however, that these others are only complications or modifications of a small group of original human tendencies. The methods of these modifications has already been indicated. Let us now consider some of the practical significances of the emotions in the life of the child.

Emotional Training of Children.—Whatever our list of unlearned emotions and however complicated their responses, let us consider how training affects them. Conditioned emotional responses are as important in the life of an individual as conditioned motor and ideational behavior.

At first the child fears very few things. Watson lists loud or sudden sounds, and lack of support as the only stimuli eliciting fear in infants. Rage was elicited by hampering of bodily movements. The stimuli for love he found to be stroking of the skin, tickling, gentle rocking, and petting. It may be that Watson missed some kinds of stimuli which arouse emotions without any conditioning process, but at least the list is not so large as we generally suspect.

As the infant meets new objects, the objects may make a noise, a sudden movement, or something else may make the noise as the object is presented. If so, then the child is likely to form a fear response toward the object presented. For example, if a dog is brought before the child, it probably will not be afraid at first, but if the dog should bark close to the child, thereafter the child will likely be afraid of dogs. If, instead of some animal, a rattle is presented to the child, and as he reaches for it a rasping sound is produced, the next time the child is presented with a rattle, he is likely to withdraw from it. It is in this way that most of the fears of childhood are built up, the majority of them in ways quite unintentional and usually unknown to the parents or teacher.

Indeed, it may be said that much of the child's emotional life grows up like Little Topsy in *Uncle Tom's Cabin.* Accidental and incidental experiences in the life of the child come to mould his attitude toward objects and life situations. If new experiences happen along with pleasant situations, he will come to like the new situations. If they occur with unpleasant situations, they will come to be disliked. Of course, some types of stimuli in and of themselves tend to be either pleasurable or unpleasurable. Strong stimuli tend to be unpleasant. Certain sensory stimuli, such as sweets, for example, are inherently pleasant. However, a world of stimuli are neither pleasantly nor unpleasantly toned and yet they come to have very definite emotional significance for us as the result of their conditioning. Certain things and people we like. This is especially true of our parents.

One of the times when we come into closest contact with our parents is during the feeding time, and in this way the parent is associated with pleasantness. Furthermore, the parent is most likely to pet and fondle the child. On the other hand, the parent most often administers punishments. He is also held accountable for many of the child's restrictions and failures. Hence the parent may be hated as well as loved, or the child may have a vacillating but strong feeling toward the parent. The love or hate between parent and child comes through favorable or unfavorable associations, as here indicated.

The emotional life of the child and hence his relation to life problems and attitude toward them as well as the attitude and opinions of others toward him depend largely upon the following conditions: (1) the child's inherent emotional make-up, (2) the type of his home training, and (3) his general relations to activities outside the home, such as school and work. These will be discussed in turn.

Some children are emotionally unstable. Something in their chemical and psychical make-up causes them to be excitable and unstable. Other children are naturally of a stolid, stable type. The first type is likely to develop into a neurotic individual or into a most pleasing personality, depending upon the type of training it receives. The following actual experience illustrates how easily the training may affect the child's attitude. After a series of games in a primary class in Sunday School the teacher asked the children how many would like to help her pick up the toys. One boy spoke up and said, "Indeed, I will not help," in a very emphatic way. No attention was paid to him, and the other children helped pick up the toys. The next Sunday the same request was made, and the same boy repeated even more emphatically that he would not help pick up the toys. The teacher turned to him and said, "I like you Johnny, and I thought you liked me. I am sorry." Then she left him alone. In a short time Johnny was busily engaged with the other children picking up the toys. After the work was completed, Johnny sat down with considerable self-satisfaction. He then called his teacher and said, "Mrs. James, wouldn't you like to see my sore knee?" This was the greatest reward he had to offer.

Here we see a delicate situation nicely handled by a skillful teacher. This boy because of his peculiar make-up, which was probably accentuated by his home training, presented a difficult problem. Any attempt to force him into submission would have tended only to aggravate his stubborn nature. On the other hand, the method employed by the teacher won Johnny's cooperation and if a similar cooperation could be secured until a habit was formed, this boy would become a social instead of a selfish individual.

The second type of child, that is, the stable type, is not so likely to deviate greatly from the norm, whatever his training. This type is likely to follow the tradition and customs of his group whatever they are. He may be successful or he may be a failure, but he will be conservative and dependable.

Effects of the Home and School.—We have already said something about the effects of home conditions. If both parents are emotionally well balanced, it is likely that the child will develop fairly normally. Especially is this true if the child is also emotionally normal. Yet in this almost ideal condition it is possible that the child will not receive the best of training. In fact, we know little about training in this field. We know considerable about how to teach a child to read or to add; we know scarcely nothing about how to develop his emotional life. It is a problem for the psychologists, educators, and parents to learn how to teach the child what to fear and what not to fear, what to love and what to hate, how to prevent worry and still not to develop an unwarranted optimism. This is real and fundamental, probably more essential to a wholesome life, than what we teach in the classroom.

A much different situation occurs when one or the other or both of the parents are unstable. Then the child may be subjected to despondency, to elation, to fits of anger, and other types of experience. One day the child is petted and unduly humored. The next day he may be punished and scolded for just the same kind of things for which he was rewarded the day before, or again, he may receive no attention. In another case the child may be continuously subjected to some one or the other of the states described above. In such homes it is really surprising if a child develops any kind of a normal personality. And yet if we study the average home, such conditions and attitudes are more common than we generally realize.

While much of the child's emotional life develops very early, and therefore is controlled largely by the home, he is, nevertheless, greatly affected by the school. Here again we may have a very wholesome, stabilizing influence or just the opposite, depending, of course, largely upon the teacher. If the teacher is irritable and unable to control or direct the children, much harm may result. On the other hand, the right sort of teacher may do an inestimable amount of good. She may become the counsellor and guide and even the idol of the child. Her influence may reflect back and help to correct much of the earlier training despite the fact that the earlier training is primary and very deep-seated.

The effect of other children in the home and in the school is another factor that cannot be overlooked. As this chapter is being written, the author has been interested in a junior high school class from normal or even superior homes but who for some reason have always given their teacher undue trouble. Their leadership and the general atmosphere of the group is of the wrong sort. Here is a difficult problem in correction and guidance. What is the cause of this condition and how may the situation be changed? If the teacher is at fault, she may be removed to some other position. If one or two leaders are the cause, they may be sent to a new environment. If it is the general class attitude, the right sort of teacher may gain the confidence of the group and get their cooperation. Yet there are other causes hard to discover and harder to overcome.

Emotional experiences are not limited to childhood. The adult is also influenced by emotions. Great crises may have a profound influence on a person. The death of a close friend, a tragedy or sickness may change a disposition. Temporary emotional states are also dependent upon physical states. Disease is a common cause of emotional upsets. A case of indigestion is likely to change one's whole attitude toward life. An unexpected gain or reward will cause a change in the opposite direction.

The Sentiments.—Certain emotional tendencies are built up toward objects which normally have no emotional significance. These are what McDougall calls the sentiments. A chair ordinarily has little emotional import, but a chair in which a departed friend habitually sat may have a great sentimental value. These connections may be very obscure and unconscious. They probably form the basis for many or possibly most of our likes and dislikes. We see a person and immediately form a strong liking for the person. We may not know why, but if we were able to analyze the situation we would be likely to find that the new person resembled a former friend in some way. The development of our sentiments, as well as the combining of our relatively simple emotions into more complex emotional states cannot receive anything except the briefest mention here. Yet it is no small part of the normal affective development of the child.

Emotional Disorders.—Because of the various factors which influence the emotional life of the child, serious disorders may occur. These vary all the way from nervousness, irritability, various psychasthenias and neurasthenias to more violent forms of insanity. While equally reliable methods have not been devised for measuring emotional disorders, they are probably just as numerous as mental disorders.

These emotional disorders result much of the time from wrong or poor emotional training. Therefore the correction of these disorders is a matter of re-education. If it is a child, the parent or teacher may be able to work out some system of training which will be correctional. However, too often the condition is due to faulty training by the persons who are attempting the re-education and it is unlikely in many cases that such persons are competent to correct a fault which they have caused. When the condition is serious, a clinical psychologist or at least some one trained in problems of mental disorders should be consulted.

The causes of mental disorders may occur in childhood and result in no apparent serious mental disorders until adult life. In such cases the discovery of causes and the methods of retraining are especially difficult. The adult may be subjected to serious emotional difficulties. These causes were especially common during the World War in the form popularly known as "shell shock." Much yet remains to be learned about the treatment of mental disorders.

No doubt 4% or 5% of the population have rather serious emotional disorders and need emotional re-education or psychiatric advice and service. One or 2% have disorders of such a nature that they need institutional care and treatment.

We have attempted to outline in this chapter some of the many ways in which the emotional life of the child is built up. Originating from very simple beginnings, emotions are elaborated into very complex mechanisms. Varied and irrational as these are, most of us are considered by our fellows as ordinary human beings. Only when the deviations become too great or the drive too much at variance with society is the person considered abnormal or insane. This general problem will receive further consideration in the chapter on Personality.

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CHAPTER 17

ADOLESCENCE

Two Special Periods in Life.—The general organization of this text has been functional; that is, we have traced the evolution of various behavior functions from infancy to adult life. This is in contrast with the method of describing age or growth periods as used by some writers.[1] This chapter violates the general plan of this text in taking up a special period in the child's life. This change of organization is justified on the basis of the emphasis which has been placed on adolescence.

Near the beginning of the present century two periods in the life of an individual began to receive special consideration and emphasis. These emphases came largely as the result of the efforts of two men, Sigmund Freud and G. Stanley Hall. Freud called attention to the great importance of the first few years in the life of the child. He placed special emphasis on sex as a driving force in the child's life. Hall emphasized the characteristics and significance of the period of adolescence.

While many of the theories of each of these men have been discredited by most modern psychologists, these writers should at least receive credit for calling attention to the importance of these two periods in life. Much of our present knowledge came as a result of an attempt to substantiate or disprove the views of these two pioneers in their respective fields. In this chapter we shall be primarily interested in the period of adolescence.

The Age of Adolescence.—At this point the problem of what constitutes the age of adolescence might well be raised. Adolescence has been defined as the period in life beginning with puberty and ending with the development of full sexual maturity. Puberty is the time of the onset of the capacity to reproduce.

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[1] H. L. Hollingworth, *Mental Growth and Decline*, D. Appleton & Co., 1927.

The age of onset of puberty differs somewhat for sex, race, occupation, and intellectual and anatomical development. It develops earlier in girls than in boys, in races living in tropical as contrasted with frigid climates, in Jews earlier than in Gentiles, in those who work out of doors and in vigorous pursuits earlier than in those living indoors. The intellectually superior as a group develop earlier than those with average or low grade intelligence. Those of large stature and precocious anatomical development reach puberty earlier than the physically inferior. For girls living in temperate climates the age of the onset of puberty is generally about 13 years. It is nearly a year later for boys. These are only averages, and deviations as much as two years in either direction from these averages are not unusual.

The date of onset is not difficult to establish for girls since it is based upon the first menstrual period. For boys the age of onset is not nearly so easy to establish. It is usually based upon the thickening and pigmentation of pubertal hair and sometimes on a change in voice.

The end of adolescence is even more difficult to establish. It is generally given as about the age of 20 or 21. This is assumed to be the age at which full sexual maturity is reached.

Hall's Theories of Adolescence.—We shall first take up what Hall considered to be the outstanding characteristics of this period and then discover which, if any, of these characteristics are borne out by later studies.

Hall's two monumental volumes entitled *Adolescence* summarize most of the beliefs of his day about childhood and youth. One cannot even glance through these volumes without being amazed at the wealth of information contained therein. This material is not limited to psychological and educational information but the volumes also contain extensive technical information in anatomy, medicine, hygiene, psychiatry, and sociology.

There is no question that Hall's writings have had a profound influence on thought and educational practice. The names of his great conceptions are still commonplace today even if they are not understood by the majority of people. Who has not heard of (1) the Recapitulation theory and its special application to the theory of play, (2) from Fundamental to Accessory, (3) Catharsis and (4) Accelerated Growth in Adolescence? Although not the originator of all these concepts, it was Hall who collected evidence for and called attention to these principles in a way that brought them into prominence.

While it is impossible adequately to present Hall's point of view in brief form, the following quotation from the Preface to Volume I epitomizes it rather well.

> Adolescence is a new birth, for the higher and more completely human traits are now born. The qualities of body and soul that now emerge are far newer. The child comes from and harks back to a remoter past; the adolescent is neo-atavistic, and in him the later acquisitions of the race slowly become prepotent. Development is less gradual and more saltatory, suggestive of some ancient period of storm and stress when old moorings were broken and a higher level attained. The annual rate of growth in height, weight, and strength is increased and often doubled and even more. Important functions previously nonexistent arise. Growth of the parts and organs loses its former proportions, some permanently and some for a season. Some of these are still growing in old age and others are soon arrested and atrophy. The old moduli of dimensions become obsolete and old harmonies are broken. The range of individual differences and average errors in all physical measurements and all psychic tests increases. Some linger long in the childish stage and advance late or slowly, while others push on with a sudden outburst of impulsion to reach maturity. Bones and muscles lead all the other tissues, as if they vied with each other and there is frequent flabbiness or tension as one or the other leads. Nature arms youth for conflict with all the resources at her command—speed, power of shoulder, biceps, back, legs, jaw—strengthens and enlarges skull, thorax, hips, makes man aggressive and prepares woman's frame for maternity. The power of diseases peculiar to childhood abates and liability to the far more numerous diseases of maturity begins, so that with liability to both it is not strange that the dawn of the ephebic day is marked at the same time by increased morbidity but diminished rates of mortality. . . . The function of every sense undergoes reconstruction and their relations to other psychic functions change, and new sensations, some of them very intense, arise, and new associations in the sense sphere are formed.

Criticisms of Hall's Theories.—In contrast with these points of view, supported as they are by a seemingly incontrovertible array of studies, let us see what more recent studies have proved.

Modern biology has clearly shown that, while there are many parallels between phylogeny and ontogeny, there are also many exceptions to this rule. Some of the phylogenetic periods have not been retained in ontogeny. For example, there is no reptilian stage in human ontogeny. Nature has omitted some of her original steps. Others have been changed in their order. Walking, for example, comes much later in ontogeny than in phylogeny. Sexual maturity also comes much later. While gill slits have been used to show the similarity of human embryonic development to the fish stage of phylogenetic evolution, we sometimes forget that a fish also has scales, fins, and an air sac. It would be difficult to show similar embryonic structure to parallel these. Therefore, any attempt to suggest causes or treatment or to predict results, based upon the assumed parallel between the development of the individual and the race, as Hall did, is open to serious question.

Hall's theory of catharsis does not agree with most modern theories of learning. While the Gestalt psychologists have attacked the laws of use and disuse and effect, even they would not argue for the principle of the elimination of a fault by practicing it. Dunlap corrected his error of writing "hte" for "the" on the typewriter by practicing for some time on the wrong form. He formulated his Beta theory of learning to account for this fact. But it is not necessary to formulate any new theory to account for this kind of learning. The general elimination of errors in trial and error learning is an example of the same thing. However, instead of eliminating bad habits by catharsis we tend, when the results of the practice are pleasing, to fix the habit. "Working the badness out" is a very dangerous practice. There is more danger that the bad practices will become ingrained into the structure than a likelihood that the individual will be purged. Our courts and correctional institutions are filled with the wrecks of a catharsis program. Of course, it is only fair to say that Hall would not carry such a program to this extreme, but even in moderation it has its difficulties. Catharsis at its best is very dangerous and at its worst it is pernicious.

Freeman in his study of handwriting has refuted the doctrine of from fundamental to accessory. While gross movements tend to precede the finer movements, we do not first use one and then the other. They both develop together with greater emphasis in the beginning on the gross movements and more emphasis later on the finer movements.

Adolescent Rate of Growth.—The doctrine of rapid physical and mental acceleration during early adolescence has received more support from modern writers than any of the doctrines set forth by Hall. Mrs. Hollingworth[2] in her recent text seems to support this view. She speaks repeatedly of rapid growth, such as growing out of clothes, etc. Furthermore, these are spoken about as though they were unique rather than that they are characteristics of the whole growing period.

She says that some adolescents grow as much as six inches in a year and may gain as much as twenty or thirty pounds in weight. In another paragraph she says:

> In the psychology of the adolescent the growth of hands, feet, and nose plays a set of rôles fully as important as those of increase in height and weight. It is well known, both to people in general and to anthropometrists, that various features of the body grow most rapidly at various periods. Thus the feet and hands attain a disproportionate size in early adolescence. These members are nearly as large as they will ever be by the time the boy or girl is thirteen or fourteen years old. The sudden increase in size, causing at the same time a protrusion of wrists and hands from sleeves previously quite long enough, and a pinching of shoes formerly comfortable, creates something of a problem for the growing individual. This problem is often further complicated by the essential ignorance of the adolescent, in that he does not know the facts about differential rates of growth and supposes that hands and feet will continue to grow as recently they have, thus reaching eventually truly enormous proportions. These acute anxieties could, of course, be prevented by information on the subject of growth.

In contrast with this point of view the reader is referred to the rate of growth curves presented in Chapter 9 of this text. These curves give evidence of only a very slight acceleration at the prepubertal period or pubertal period. The acceleration is so small that it is not apparent on the graphs drawn from these tables. It may be claimed that these are averages, and since puberty comes at different ages for different individuals, these accelerations are hidden in the averages. As an answer to this contention the reader is referred to the following graphs of individual growth curves of approximately 60 boys and girls as presented by Baldwin.

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[2] Leta S. Hollingworth, *The Psychology of the Adolescent,* D. Appleton & Co., 1928, p. 8.

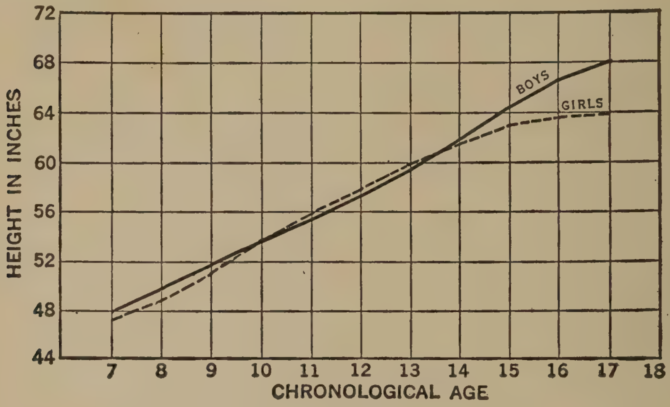

Figure 60. Growth in Height (Baldwin)
Based upon retests of approximately 60 boys and girls at each age.

Baldwin's further studies of growth in body structure do not show that growth is much more irregular at adolescence than at any other period. It is irregular at any age in the sense that any body part, such as length of the forearm, does not grow at a constant rate. These studies also show that at one age some body parts grow more rapidly and at other periods other parts grow more rapidly. However, the studies do not show much greater irregularity at the onset of adolescence than at other periods for many parts of the body.

Other Changes During Adolescence.—It is not to be inferred from what has just been said that there are no physical changes at adolescence. There is a rapid development of muscle tissue in certain parts of the body. Layers of fat develop, especially in certain parts of the body in girls. There is also a change in the shape of certain bones, particularly the long bones of the legs, and a flattening of the pelvic bones. These changes give the adult body form as contrasted with the shape in childhood. Sex organs enlarge and become functional. The secretions of the gonads produce the secondary sex characteristics in addition to those already mentioned, such as the growth of the beard in the male, the increase and pigmentation of pubic hair, and the change in voice. These are some of the physical changes which are apparent during early adolescence.

In Chapter 9 several graphs of growth of different parts of the body were presented. These were largely taken from studies by Scammon and Baldwin. The following graphs summarize some other studies by Bean and Vierordt on growth. In none of these graphs is there any real evidence of a significant adolescent spurt in growth.

It has also been claimed that there is an adolescent spurt in mental growth. Terman's[3] records seem to show some changes at adolescence. But since I.Q.'s are determined in terms of the performance of normal children for each age, comparisons between ages are not safe measures of mental progress. National Intelligence Test scores and Otis norms show no significant variations for different age groups of the adolescent period.

Another change at adolescence which is sure to attract much attention is a change in voice. While most noticeable in boys, such changes also occur in a lesser degree with girls. As the child grows older the vocal cords become longer and the voice resonance chamber larger. These changes result in a lower speaking and singing voice. This lowering of pitch proceeds somewhat regularly during the growing years of childhood. However, about puberty the change becomes greater and more sudden. Especially in the boy the voice may "break" as he speaks or sings. His voice may shift without apparent cause from a high to a low pitch, from low to high, or alternately back and forth from one to the other. Such shifts are probably due to a rather rapid change in the vocal cords and other parts of the speaking mechanism resulting in a partial loss of control. But what is the cause of a sudden growth in size of the speech organs?

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[3] L. M. Terman, *The Measurement of Intelligence,* Houghton Mifflin Co., 1916.

We do not know, but it may be something similar to and due to the same causes as the growth of the beard and fatty deposition already described in this chapter.

The awkwardness of the early adolescent child, especially the boy, has received much attention in supposedly scientific writings and in popular and humorous writings as well. Is the adolescent boy more awkward than when he was younger or than he will be when he grows older? Fortunately we have charts of strength and skill for various school ages both before, during, and following the onset of adolescence. Hollingworth and Poffenberger[4] give curves for tapping, form board performance, cancellation, and grip. (See also Figure 63 in this text.) There is nothing about these curves to indicate a difference between ages 13 and 14 and other ages except possibly a slight reduction in grip records. Pyle[5] gives records for tapping for more than 8,000 children of different ages. These show no significant changes at adolescence. The large majority of motor tests included in

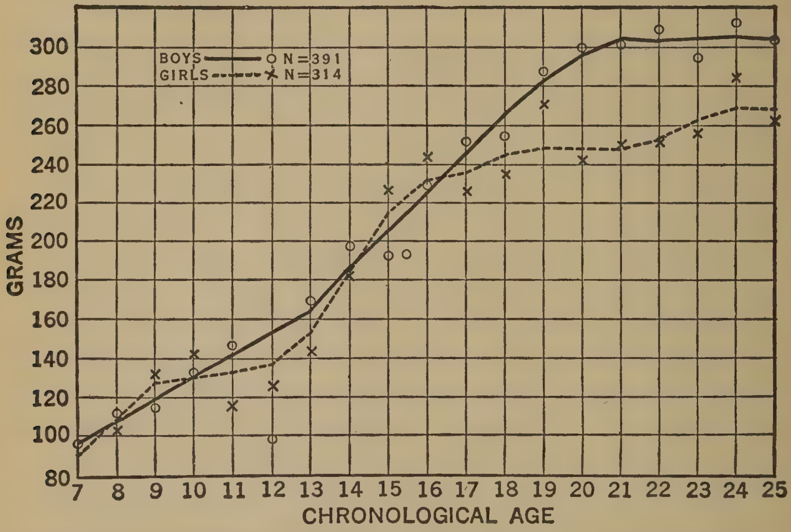

Figure 61a. Weight of Heart at Different Ages. Curves Smoothed. (Bean, Vierordt, *et al.*)

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[4] H. L. Hollingworth and A. T. Poffenberger, *Applied Psychology,* D. Appleton & Co., 1923, pp. 123–125.

[5] W. H. Pyle, *The Examination of School Children,* The Macmillan Co., 1913.

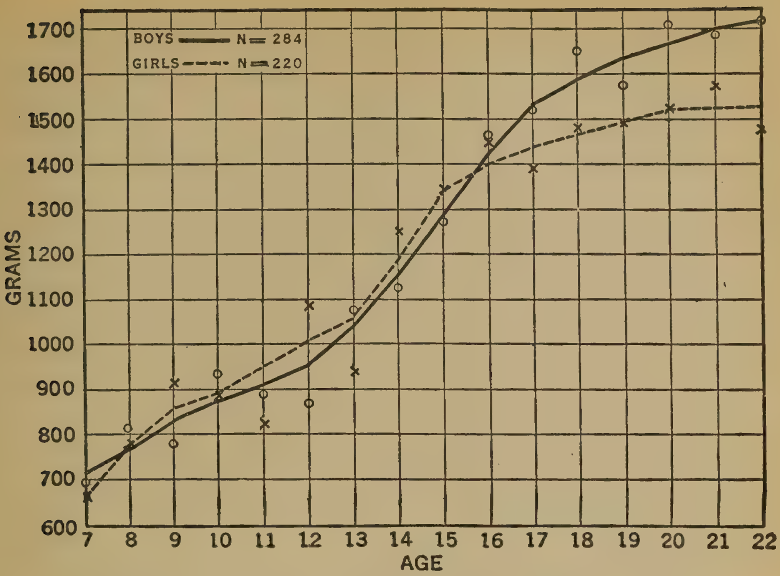

Figure 61b. Weight of Liver. (Bean, Vierordt, *et al.*)

Curves smoothed. These curves are based upon too few cases to be an accurate indication of growth. Accordingly, we cannot be sure about the sex differences which they reveal.

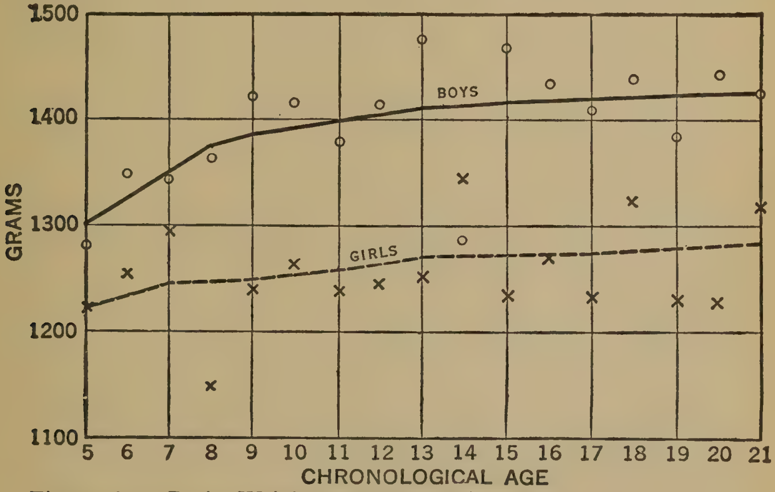

Figure 61c. Brain Weight at Different Ages. 219 boys; 215 girls. (Vierordt)

Curves smoothed. The unreliability of these curves becomes apparent when we note the irregular distribution of the small circles and crosses, which represent the mean weights at the different ages.

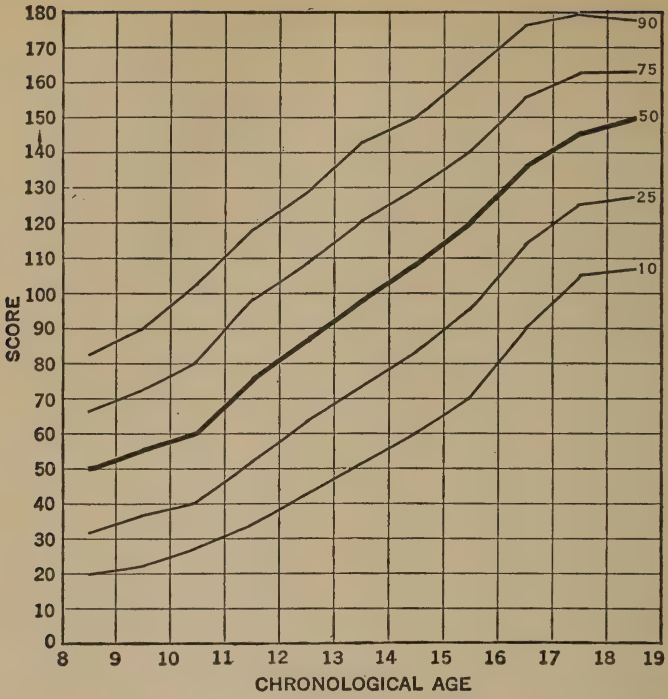

Figure 62. Percentile Scores, Ages 8 to 19, on the Otis Group Intelligence Scale, Advanced Examination. N = 25,226.

(F. D. Brooks, *The Psychology of Adolescence,* Houghton Mifflin Co., 1929)

Pintner and Paterson's[6] Performance Tests show no loss of skill during early adolescence.

Causes of Mistaken Ideas Concerning Adolescent Spurt. How then have these notions of adolescent spurt of growth and the idea that the early adolescent is awkward been derived? There are at least two or three reasons. First, there is rapid growth during adolescence. The only point is that it is not much if any greater than at other periods in youth. Second, there are certain changes of a physical, emotional, and social character—which will be described more in detail later—that put the adolescent youth in a new relation. He "puts away childish things" and becomes an adult. He ceases to associate with children; the boy begins to seek the company of men, the girl that of women. The dress is changed to accord with this new status. These changes call attention to the change in status. New clothes and new associations make the difference. The child now looks "grown up." He looks awkward in the new clothes. He is shy in the presence of elders and especially the opposite sex. This all makes him *appear* awkward.

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[6] R. Pintner and D. G. Paterson, *A Scale of Performance Tests,* D. Appleton & Co. 1925.

What, then, in addition to certain physical changes, does occur during this period? The most important ones have just been mentioned. Probably the most significant of all is the development of sex. Sex is a factor in the life of the child. In both male and female sex stimulation is possible and apparent in the early life of the child. However, it is several-fold more significant when sexual maturity begins. This difference is of

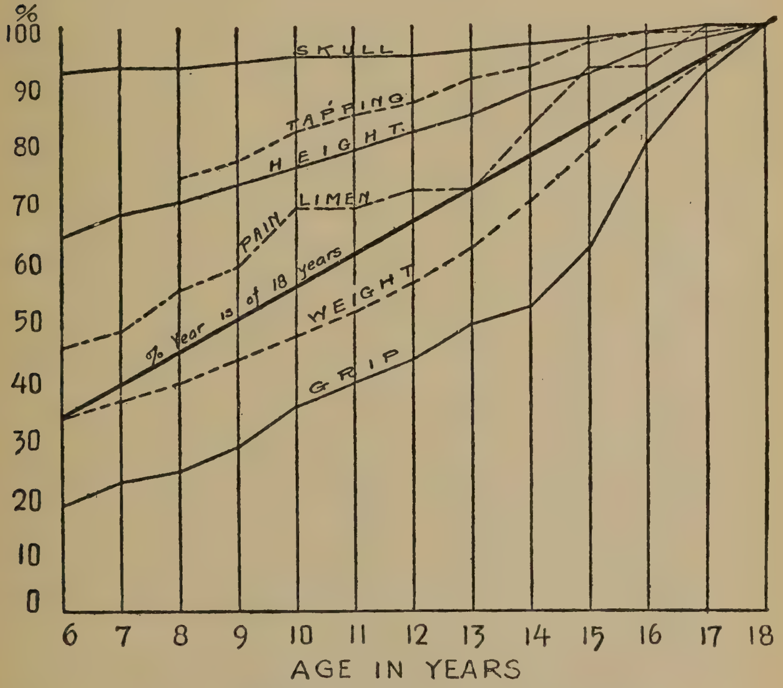

Figure 63. Rate of Development

In terms of the per cent of the 18-year record reached by each year

(H. L. Hollingworth and A. T. Poffenberger, *Applied Psychology*, D. Appleton & Co., 1923) two kinds: first, the boy or girl is more stimulable by sex objects and such come to play a more important rôle in life; second, the realization of sex and its significance in life brings such objects further to the fore.

Adolescent Ceremonies.—In primitive societies these facts are recognized and heralded by rather elaborate initiation procedures. In his early years the boy is generally cared for, educated by, and lives with his mother, younger brothers, and sisters. As he grows older his father takes over more and more of his instruction. From his father he learns to fish and hunt and something about fighting. When he arrives at a certain age near puberty, he is subjected to intensive training leading to the initiation ceremony. The purpose of this training, which may be verbal or otherwise, is to impress upon the maturing boy the nature of his obligations and responsibilities in his new position in the tribe. He is to become a warrior. He will sit with the elders in councils of war and peace. He will soon take a girl of his own tribe or forcefully seize one from some hostile tribe for a wife. The customs and taboos relating to all these new relations in life are explained to him by word of mouth or by example.

The initiation ceremonies[7] vary greatly from tribe to tribe and race to race. In some of them, rigorous and even savage treatment is used, such as pulling out the hair, knocking out the teeth, forcing the carrying of live coals in the bare hands, heavy flogging, circumcision, etc.

In many tribes the girls are also put through a system of training for life tasks. It is the practice among some natives of Alaska to banish the girls for six months after the onset of puberty. The girl is forced to live in a small hut and is not allowed to leave her confinement except at night under the guidance of her mother. During her imprisonment she is kept busy making blankets, tents, and clothing. At the end of her training period there is a celebration or "coming-out" party. After this, she is eligible for selection as a wife by one of the young men of her tribe.

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[7] For a more extended account of pubic ceremonies see Leta Hollingworth, *op. cit.*

The form of ceremony varies greatly from tribe to tribe among primitive peoples but the purpose is similar. Sometimes the ceremony is exacting and cruel. Often there is no virtue in the ceremony, whatever its character. There is a realization that new duties are about to be entered upon, and these ceremonies are an attempt to prepare the girl for her new duties and responsibilities.

In such primitive societies as here described or in their earlier counterparts it is not to be understood that sexual practices were on a higher plane than in modern society. It is true that certain taboos and customs with severe penalties for infringement protected certain members of the tribe. However, we need only read unexpurgated editions of ancient writings to get some idea of actual as well as approved practices.

Sex Changes and Their Significance.—This sex change that occurs at puberty has, as we have seen, profound social significance. It is not within the limits of this text to elaborate upon this topic but it is not difficult to realize that the whole development of romanticism both in practice and in literature and art as well as the institution of the home are largely built upon the normal expression of the sex instinct. Any motivating force as great as this has not only the possibility of normal expression but also of abnormal expression. In its perverted forms sex is tied up with the causes of various forms of insanity and it forms one of the most if not the most important causes of crime.

Closely connected with the sex instinct is the emotional life built around sex. In fact, it is impossible to separate the instincts and the emotions related thereto. Suffice it to say that these instinctive and emotional drives connected with sex—and they become so much stronger at puberty—are sufficient to account for most if not all the changes which take place at this period in life.

Enough has already been said to indicate that the social changes which occur at this time depend upon biological changes. The initiation of the primitive youth into the councils of his elders was based upon the realization that at this time the child was becoming an adult with potential capacity, at least, of becoming a parent. His former associations had to be broken and new ones found.

Even in modern times we have coming-out parties for the adolescent youth. Commencement exercises and confirmation ceremonies are symbolical of the change from childhood to adulthood. The new associations of this period are typified by the formation of boys' gangs. There is a definite break in school life, some children leaving school to go to work, others transferring to junior high schools and later to high school and college.

Since sex is the one significant change that occurs at adolescence, the question arises as to what is being done in the way of preparation for the change. What sort of education has been evolved to prepare for and care for this change? Here is a field in which prudishness rather than any constructive program has developed out of the old taboos. Instead of being taught the simple facts about sex and its significance, the child is left to find out what he can from his playmates. In many homes and schools there is absolutely no instruction and questions on the part of the child are ignored or evaded. The information which is received from other children is fantastic, lurid, and misleading in character. The sensitive boy or girl becomes frightened over perfectly normal functions and either worries or seeks some unwise means of relief.

Sex Instruction.—Instruction in sex logically should be given in the home. Two facts account for its not being given there: first, parents are often not prepared either with information or methods of imparting it; second, parents are often timid or averse to giving such information to their children.

Ordinarily the schools have taken over instruction which has been or should be given in the home. This has not generally been true in the case of sex instruction. In this subject the schools have usually failed to assume the responsibility. Such instruction is omitted or slurred over even in courses in biology, botany, and physiology. It is rather surprising that our abnormal psychology and hygiene courses in colleges and universities are doing more in this subject than in almost any other part of our school system. The instruction here comes too late to do the most good and probably reaches those least in need of such training. Yet it may be the hope of the future that the teachers now being trained and some of the parents of the next generation are receiving such instruction. There seems to be a rather rapid change at present toward a more wholesome attitude toward sex. It may be that some of the present tendencies may lead to a more intelligent form of instruction in this subject in the next generation.

The writer has asked several of his classes in social psychology their attitude and opinion of the desirability and need for the teaching of sex hygiene in the home and in the school. The almost unanimous agreement of the classes has been not only that it should be taught but that it is very imperative that it be taught. If such opinions among the social and intellectual leaders of the coming generation are universal and strong enough, there is sure to be a change for the better.

In fact, it is only fair to point out that in a few places such a movement has already begun to function. There are a few elementary schools in which such instruction is now being given with considerable success. In Winnetka, Illinois, such training is being given in connection with the work in nature study. When it was first begun several years ago, some parents were very skeptical and others were openly antagonistic. As a result of the agitation set up, the parents were called in for consultation. The method and nature of the instruction was carefully explained. As a result, not only was the instruction approved, but a class for the parents was organized. Several other schools have had similar experiences. This is evidence that such plans are feasible.

It is true that there are difficulties and dangers attached to such instruction. One danger is that sex instruction may lead to undue curiosity on this topic. This depends largely upon the nature of the instruction and the spirit in which it is given. Another difficulty arises in connection with how it shall be given and by whom. These are serious problems and must be faced, but they are not insurmountable difficulties.

We must weigh such difficulties against the results of a lack of such instruction. This too often results in sexual immorality of all kinds. To this must be added the great amount of emotional unrest which is traceable to such causes. It is really surprising, under the circumstances, that so many people are able to make a fairly normal adjustment rather than that so many go wrong.

Most of this chapter has dealt with the earlier part of the adolescent period. As we have said, adolescence begins at about 13 years and extends to 20. The emphasis has been placed upon the early part of this period because it is here that right practices and normal thinking must begin. It is also here that difficulties begin. While the criminal may not commit a crime sufficient to bring him before the courts until he is 16 or 18, the habits and attitudes which eventually lead him into crime are probably determined at this period. And while it is not usual for an individual to become insane before 17 to 20 years of age, it is often the stresses of the earlier years of adolescence that cause the breaks at these later ages. Hence the emphasis on the earlier rather than on the later part of the adolescent period.

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CHAPTER 18

THE GROWTH OF PERSONALITY

Nature of Personality.—Every applicant who is considered for any position of consequence must possess in addition to professional fitness certain favorable traits of personality. These are indicated in letters of recommendation and personal interviews. Even in some of our colleges and universities with restricted registration in addition to the requirement of graduation from high school, students are selected on the basis of certain traits which are believed to be favorable for their success in college and after graduation.

What, then, is meant when a man is said to possess a pleasing personality, to be intelligent, aggressive, and a good mixer? How has he acquired these traits, and how does he differ from other people in his community? These are some of the important problems of this chapter.

However, until certain terms are defined or explained, our discussion is likely to be vague and ambiguous. Often very common words are used in describing personal traits. The difficulty in understanding many of them is that sometimes they are used with one meaning and sometimes with another. For example, what is meant by the terms, self, personality, and character? These terms are often used synonymously; sometimes self is used as the broader term including personality; and sometimes character is the broader term. In this chapter self will be used to designate man's composite nature. It is used in this broad sense comprehending him in all his relationships. Personality will be used to refer to the social elements in self. Personality is the way in which any one impresses his fellows. Character will be used in reference to the moral or ethical phases of personality. It is that phase of life which is evaluated on the basis of right or wrong.

William James used the term self in the sense described above and was the first person to make a clear analysis of self. He analyzed self into three parts: the material self, the social self, and the spiritual self. Each of these is the result of training. The child at birth does not distinguish between self and not self. It has no notion of self. Gradually as a result of experience it begins to distinguish between its bodily self and other things in its environment. The child continually sees its own hands and other parts of the body. These are the constant factors in his various situations. He also bumps his fingers and toes. The pain resulting therefrom is very personal. Out of this complex of experiences the child begins to evolve the idea of his body as himself. It is this self which parents and others call by name. It is this which he sees in the mirror if he is allowed to see himself.

As this knowledge of his bodily self increases, the child begins to develop a knowledge of other material things in relation to himself. That is, his toys and his clothes belong to him. These are his material possessions and are generally uniquely personal. The child is not very old before he begins to assert his rights in regard to these possessions. He is often wrong and tries to exert his rights beyond his possessions, but this only helps him in his ideas of mine and not mine.

There is another class of objects such as parents, home property, school, some of his toys, and many other things which he may possess in part and share at times with others. Nevertheless, he can use the term "mine" in connection with them. All these things constitute what James meant by the material self.

James speaks of another self called the social self. This is a man in relation to his fellow man. In this relation man is appraised by and appraises his friends and acquaintances. It is this phase of his self that we have called personality. It is this side of the individual in which we are primarily interested in this chapter.

The social self, like the material self, is built up by experience. We might say that the man without any social relations would have no personality. However, this is a theoretical problem as "no man liveth unto himself alone." Even Robinson Crusoe had experienced the effects of socialization before his shipwreck. With the coming of Friday the social situation was restored.

Let us trace, then, in some detail the elements in and the way in which these elements are related in the formation of personality. Those most responsible for this development are his parents. Other children in the family, if there are any, are also important influences. Playmates, as well as other persons with whom the child associates have their part in his development. When the child starts to school the teacher as well as his classmates add to his social relations. If he attends church or Sunday school or plays in street gangs, his social contacts are further broadened.

Genesis of Personality.—Even before the child has any clear conception of himself as a person, the influence of close associates begins to affect him. The person most closely associated with him is his mother. From the very earliest beginning his mother is the source of his greatest happiness. It is she who provides food for him. His very being depends upon her not only before but after birth. Especially during the feeding, coupled with the pleasures of food are the pattings and caresses from the mother. In a hundred other ways the mother becomes a benefactor or a deterrent influence. Bernard[1] says:

> He copies her acts of affection, such as caressing with his hands, kissing, pressing his cheek against the mother's cheek, cooing in response to her cooing, smiling, and even a little later responding to signs of fear and anxiety, the expression of anger, defiance, general emotional disturbance, such as nervousness and the like, when the mother exhibits these before him. He adopts her tone of voice, forms of expression, gestures, even carriage, and the attitudes of sincerity or insincerity, her benevolence, devices of lying or evasion, social graces or the lack of them as soon as he can recognize them. He becomes a stronger advocate of conventional practices or "good manners" in eating, dress, social intercourse, and the like, than his own mother if she conditions strongly such responses in him. It is not uncommon to observe a child adding its own advice and admonition to that of the mother in holding the older children who are beginning to differentiate their responses according to choice, down to their conventional obligations around the home.

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[1] L. L. Bernard, *Introduction to Social Psychology,* Henry Holt & Co., 1926, p. 342.

There is much truth in these statements but they fail to indicate the varying degrees to which the mother extends this influence. Two major factors determine the relative influence of the mother upon the child. The one is the degree of love of the mother by the child. If the mother gives the child great happiness through her ministrations and general social relations, the influence will be positive. Sometimes, on the other hand, the child develops such a dislike for the mother that he both consciously and unconsciously develops habits and attitudes diametrically opposite to the mother. Whatever she does, he will not do; whatever she likes he dislikes. This influence may be complete or partial. In some things the child may concur and in other things he may not concur. Likes and dislikes in regard to foods is one common source of such attitudes. If the mother is oversolicitous or becomes emotionally disturbed about the child's eating, he may connect the emotion with the food and form a strong dislike for it. These and other similar differences form the basis for personality dislikes between mother and child.

The other factor which affects the amount of influence of the mother on the child is the number of other people with whom the child comes in contact. If the mother is a widow and the child an only child, the influence of the mother will naturally be much greater than in a normal family of four or five persons. Let us now consider the influence of some of the other people with whom the child comes in contact.

First of these, of course, after the mother comes the father. But generally the father's influence is not so great as that of the mother. This is largely due to the fact that the father is not so much in contact with the child when it is most impressionable. He does not directly provide the food and, as a rule, few of the bodily comforts, especially in the early years of the child's life, and very often he administers the punishments. This may cause a fear and dislike of the father.

Yet the father may be the ideal or the hero for the child. His usual absence through the day may add to his influence. He comes home in the evening and plays with the child, brings him toys and candy. It is he who takes the child on auto rides and provides money for the movies. As the child grows older the place of the father as compared with the mother is likely to become relatively larger. This is due to the fact that the mother is not so much with the child and the father may be with him even more.

Other children in the home create a situation in which the child must learn the give and take of social relations. These relations may work themselves out experimentally or they may be directed and supervised. In the first case the outcome depends much upon the relative ascendency of the child in question. He may learn to be a leader, a bully, a snob, a tease, a tricky child, a whining child, a subdued child, or any other of the many possibilities in a social situation. The same outcome may come under supervision but in a different way as previously suggested.

Playmates have a similar effect upon the child but generally to a lesser degree, since they are less often present and not present at the most significant times such as mealtime, bedtime, and the like.

When the child goes to school he is thrown into a new social situation. The teacher takes the place of or adds to the influence of parents, and the other children in the room become more or less as brothers and sisters. Great as the influence of the school is it cannot be given credit or held fully accountable for the child's behavior. This is true, first, because the child comes to school with well-formed habits of social conduct. Even the kindergarten gets him too late to overcome a strong home influence which has already been built up. Secondly, the school has the child only four to six hours five days a week for eight to ten months per year. This is not half the child's waking life. The remainder of the time is spent at home, at work or at play, by himself or with others.

High school and college, the work shop and the factory introduce further problems of social adjustment. Sometimes these adjustments present most serious problems for the young man or woman. They generally mean more or less separation from home influence. The young man who has grown up under favored home surroundings and particularly when he has been shielded from the world, when thrown with another group as he is in college, must make a great social adjustment. He finds that much that he has been taught and has believed is not the accepted code of his new group. His courses in high school and college, especially in science, may seemingly disprove the sources of his former faith. As a result he may discard his past, so far as this is possible, and begin anew. Such conditions are no uncommon cause for serious conflicts and even emotional breakdowns. When less severe they often lead to cynicism and skepticism. Even the good of the past is discarded with the bad.

Personality Characteristics and Disorders.—Such influences as have been mentioned cannot help having a profound effect on the child. Indeed, what he becomes is dependent upon these influences. However, the influences are very complex and the resultant personality traits varied.

We may consider some of the possible outcomes. The most fortunate outcome is a happy well-adjusted attitude toward people and life problems. While the character of these adjustments may vary from individual to individual, yet the general tenor of such a life is a sane, sober, consistent facing of problems and a solution in terms of past experience. This does not mean that such a person will have no worries. The worries, however, will be based upon real dangers and not imagined ones. Instead of resulting in inaction they will, wherever possible, lead to prevention of the impending danger. Where the effects cannot be avoided, as in cases of death in the family, real suffering will result; but in all such instances a clear perspective will be retained. Not all problems, economic, social, and moral will be solved satisfactorily. However, an honest attempt at solution will be made in each case. Such, in brief, is a healthy, normal life adjustment.

There are some people who make satisfactory life adjustments part of the time and at other times do not. They are not integrated, not consistent. Certain factors in their lives have been normal; other factors have resulted in conflicts. In some individuals this results in a split personality—a Dr. Jekyll and Mr. Hyde type. In other cases there is no splitting but a vacillating personality. It is not necessary to subscribe to any doctrine of psychoanalysis to realize that conflicts exist. As Overstreet[2] has suggested, most of us are more or less unadjusted. The great majority of us, however, get along fairly well most of the time.

If we do not and our maladjustment is serious, we develop some kind of a psychosis. We develop an aggressive, belligerent, or negative attitude toward life. This is the typical manic state. Or we may withdraw from life's problems. This is the typical schizoid or dementia praecox response. Drugs or drink is another attempt at release or escape. Crime represents another type of maladjustment. This is not the place for an extended discussion of this topic. It is only to point out the possibilities of such personality problems that it is mentioned here.

The Traits of Personality.—Thus far in this discussion personality has been treated as a unitary affair. In a very real sense it is such and nothing else. But for purposes of accurate description, analysis is valuable and necessary. Much as any description of an irregular solid requires several separate measures to describe it accurately, so must personality be described. We shall therefore attempt to analyze personality into its constituent elements and describe each. Some attention will be given to the origin of these traits and how they differ from one person to another.

Authorities are by no mean agreed upon the list of human traits. Even the number of characteristics listed by different authors vary from five or six to more than a hundred.[3] It seems to the writer that a shorter list is more valuable even at the possible expense of completeness and all-inclusiveness. Allport's[4] list has many advantages but his subdivisions under the main headings are not always clear-cut and distinct. If I were to give a list it would include (1) social intelligence, (2) personal appearance, (3) morality, (4) emotionality, and (5) aggressiveness.

How do these characteristics develop and why do people differ so much in these traits? These are fundamental problems in personality. In the discussion of the origin of personality traits the question arises as to whether there is an hereditary basis for traits. On this question, like all such questions, there is a difference of opinion.

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[2] H. A. Overstreet, *About Ourselves*, W. W. Norton & Co., Inc., 1927.

[3] A. R. Gilliland, "Problems of Personality," *Journal of Abnormal and Social Psychology*, (1928) Vol. XIII, pp. 369–378.

[4] F. H. Allport, *Social Psychology*, Houghton Mifflin Co., 1924, Ch. V.

The evidence from endocrinology is very strong that the excessive functioning of certain endocrine glands or their underactivity has a profound effect upon personality. Although too much is claimed by popular writers on the subject, nevertheless the careful work of such men as Cannon[5] and Crile[6] is conclusive proof of their importance. There are other types of chemical changes such as body acidity, phosphorus content, and creatinine content of the blood. Rich[7] has found certain indications that the presence or absence of large quantities of these substances is correlated with personality characteristics.

Without necessarily accepting the view of Kretschmer[8] that bodily form is directly and invariably related to certain personality traits and even to corresponding forms of insanity, we may believe that there is considerable truth in Woodworth's[9] doctrine of *physique* and *chemique* as important contributing factors.

Significant as the hereditary factors are in personality, the environmental factors are more important. They are probably the larger factors and they are the ones over which the person has control. Let us trace such factors briefly.

Children brought up under very similar social conditions often differ greatly in their personality traits. Even children brought up in institutions from earliest childhood, while more nearly alike than most children brought up in normal homes, vary significantly. Some of the ways in which these influences affect the child's life have already been stressed. Our next problem is the analysis of the separate factors in personality.

Personality Traits and Their Development.—

1. SOCIAL INTELLIGENCE. Social intelligence or sociality, as it has sometimes been called, differs from general intelligence

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[5] W. B. Cannon, *Bodily Changes in Pain, Hunger, Fear, and Rage*, D. Appleton & Co., 1929.

[6] G. W. Crile, *The Origin and Nature of the Emotions*, W. B. Saunders Co., 1915.

[7] Gilbert J. Rich, "Body Acidity as Related to Emotional Excitability," *Archives Neurologie and Psychiatry*, (1928) Vol. XX, pp. 589–594, and "A Biochemical Approach to the Study of Personality," *Journal of Abnormal and Social Psychology*, (1928) Vol. XXIII.

[8] E. Kretschmer, *Physique and Character*, Harcourt, Brace & Co., 1925.

[9] R. S. Woodworth, *Psychology*, Henry Holt & Co., 1929, Ch. XIII.

in two ways. It has to do with the application of intelligence to understanding how to get along with people. A person may be intelligent in school subjects, in economic affairs, or in mechanical activities but not able to get along with and control people. It is this social intelligence that is necessary in executive control and direction. There is another element in what is meant by social intelligence. The socially intelligent person must also be interested in people. Such a person must like to be with people.

How does a person become socially intelligent? It is no doubt true that personal appearance is a favorable factor. There may be some other inborn tendencies to cooperation. It is found in animals but much more in some than in others. Both cats and dogs are born in litters and grow up in groups, but the cat is a solitary animal and the dog hunts in packs, associates with his own kind, and seeks association with human beings. This gives some indication that the greater gregarious tendency in dogs is inherent.

However, in human society the children who live in groups are almost sure to be more social than those who live apart. Probably, as a group, city children are more sociable than country children. There is a fund of knowledge of how people react and what is necessary to secure acceptance in the group—in a word, the rules of cooperation—which a person must know and practice before he can be social. The child raised in a home where these facts are common knowledge and where they are practiced is almost sure to be social. The child reared in a home where such practices are not common is not likely to be social.

There are certain cases in which the normal social growth does not occur. The child in a highly social home may react unfavorably to this feature of the home. He may dislike and withdraw from it. Again, the child from the unsocial home may have a desire to change this state, and there are many ways in which he may do this. Lincoln was reared in a poor, lonely home. He rose above this condition, learned how to get along with people, became interested in politics, won his constituents not only by his logic but by his kindly human nature. Thus we have the background of one of our most beloved figures in history.

The boy from the poor city slums may learn how to cooperate and control his street gang. In this case it makes little difference whether the gang becomes a boy scout patrol or a gang which pilfers from every available source in the community. In either case the boy who has the ability and the interest to pursue his course will become a leader of his group.

Although general intelligence is a factor in sociality, it is not the controlling factor. Persistence and interest may conquer. We need only consider the typical ward politician as an example to prove our case. Neither is wealth or social position necessary. The society leader is one type of social individual and the itinerant street missionary is another. Both learn, practice and enjoy associating with people of their class.

2. Personal Appearance at first thought might seem to be almost wholly a matter of inheritance. On the other hand, physical form and beauty do not constitute all of what we mean by personal appearance. A person may lack beauty or actually be ugly in form and facial features and still present a pleasing personal appearance. So far as we know no one ever accused Abraham Lincoln of being an especially handsome man and yet he was characterized by his contemporaries as a man of a most unusually pleasing appearance. Personal appearance is a matter of clothes, voice, carriage, personal hygiene, and other less apparent elements.

Personal appearance is one of the most important factors in social relationships. Its presence often compensates for some of the other traits. How easy it is for the person of pleasing appearance to gain a hearing where others fail. It is not only the private secretary that is selected for her appearance; the bank or college president may secure his appointment not because of a lack of other graces but because he possesses in addition a pleasing personal appearance.

3. Morality as used in this connection is a personality trait. It refers to the degree to which a person lives up to the principles of right conduct of his time and place. Not all conduct is moral or immoral. Many acts have no relation to morals. Whether a man is a day laborer or a professional man, a farmer or a drug-

gist makes no difference. It does make a difference in any case whether he does acts which harm himself or other people. If he injures without cause or steals, he is immoral.

Morality is not static. At one time it was moral to steal so long as one did not steal from his own tribe. Likewise it was not wrong to kill outside the tribe. Furthermore, standards of right and wrong vary from one social group to another. The same standards of right and wrong do not hold for the Bushman and the cultured European. The same code does not hold for New York or Chicago gangsters and for Sunday Schools. Some reformers of society may be so far ahead of the group that they are actually immoral by the standards here set up. However, despite all these variations there are certain ideas of right and wrong common to the great mass of humanity in any community which form the standards of moral conduct.

4. EMOTIONALITY might well be named as another personality trait. By emotionality as here used we do not mean exactly the same as in Chapter 16. It is here used in the more popular sense of excitability or nervousness. Its opposite might well be called stability. People differ greatly in this trait. There is probably more of an innate basis for these differences than any other we have studied with the exception of personal appearance. Some people are naturally high strung while others are slow and easy going. Hyperthyroidism is a common cause of nervousness and irritability. Sickness of any kind tends to produce emotionality. Obesity may be a common cause of stability.

However, this trait may be greatly influenced by training. Almost any child when put into some situations becomes nervous. An illustration of this was recently related by a friend. His son, 5 years of age, was sent to a public kindergarten where there were forty other children in attendance. There was one teacher and two assistants. These teachers were unable to control such a large group and keep them interested. As a result the room was always in confusion. While the boy was normally calm and was accustomed to association with other children he was greatly disturbed by the excitement of the schoolroom. He began to lose his appetite and was unable to sleep at night. This condition was so rapidly becoming worse that the boy had to be removed to another school where there were only ten or twelve children and two excellent teachers. He immediately became adjusted to the new school and is now doing good work in his new environment.

A certain amount of emotionality is desirable in any person. There are some things that we should become excited about. This is especially true if we can become excited without losing our heads. On the other hand, too great excitability is not a commendable trait. Normality lies somewhere between either extreme.

5. Aggressiveness or forcefulness may be listed as one of the personality traits. People differ greatly in their attitude of attack or withdrawal from life's problems. Some persons are always ready to attack any problem that confronts them. Others approach every problem with hesitation and trepidation. It might be expected that the large strong person would be most aggressive. This may tend to be true but there are so many exceptions that the exceptions may outnumber the rule. We can all think of so many small assertive persons. Theodore Roosevelt especially in his younger days was small and weak but no one would accuse him of being other than highly aggressive. Aggressiveness is a matter of habit rather than of physical status. The child that forms the habit of overcoming obstacles will become aggressive. The child that is overawed by parents and playmates will become submissive.

There are other character traits than the five we have just mentioned. Some of them are rather important, yet if we could accurately and adequately describe any person on these five traits we would have a fair picture of him in his relation to his fellows. Some of the other traits that have been listed are combinations of those we have discussed.

Significance of Personality Differences.—Every person is different from every other person. In relation to other people this difference can largely be described in terms of the five traits which we may consider as variables. One person may have a great deal of aggressiveness, average intelligence, much sociability, a good personal appearance, and about average morality.

Such a person would differ markedly from another person who is very unaggressive (retiring), highly intelligent, unsociable, possessing an average personal appearance, and of the highest moral character. In such terms we may differentiate people from one another.

It is on this basis that we may say that some people are fitted for certain kinds of work and not fitted for other kinds. The first person described in the preceding paragraph with proper training might well make a good salesman, the second an ordinary college professor.

This is only another way of saying that such characterizations form the basis for a major step in vocational guidance. When we arrive at the place where we can give adequate quantitative descriptions of the major personality traits, we will have gone a long way in being able to guide the young in the vocation for which he is best fitted. There is a second problem of discovering what capacities are required for the different occupations. But that will be an easier problem and will be done as soon as we are able to give adequate descriptions of personality differences.

Personality analysis has a wider value than its vocational use. The individual may become interested in his own personality. He may decide he is not what he wants himself to be. If he is able to analyze himself, learn his weaknesses, and discover the methods of remedying his condition, he may set about changing his personality. Teachers and friends may aid in the process. Truly we are the guardians of our own destinies.

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CHAPTER 19

THE GROWTH OF CHARACTER

What is Character?—Much of what might have been included in this chapter has already been stated especially in the chapters on Emotions and Personality. In fact, from the psychological point of view it is doubtful whether there is much to say on the subject of character which might not have been placed under these two headings. In addition to a more extended discussion of the problems raised in the last chapter, one new point of view will be raised in this chapter. While conduct is essentially social, there is the relation of the individual to himself as well as to the group. The individual always has the problem of what he considers to be right conduct. This is the problem of ideals as distinct from the group standards of conduct. As will be pointed out later, it is on the basis of the formulation of ideals, which are above that of the group, and only upon such a basis that moral progress ensues.

Contrary to the doctrine of the older theology, the child is not born with any conscience or sense of right and wrong. Such ideas are the result of growth. Conceivably a child might be trained in such a way that his ideas of right would be diametrically opposed to those of modern society. In fact, if we study the ideas of right and wrong of early races or modern retarded races, we find that much of what we now believe to be right was not so accepted at one time in the history of civilization. As was pointed out in the preceding chapter, even in modern society the ideals of different social groups vary greatly. The street urchin and the Sunday School child are likely to have different ideas of right and wrong.

There are, no doubt, as writers have pointed out, certain innate bases for conduct. There may be some instinctive and emotional elements which predispose a person to either moral or immoral conduct. However, no instinct or emotion is of itself either moral or immoral. The instinct is a tendency to act. Whether the resulting action is moral or immoral depends upon *how* it is expressed. Food-getting is moral when food is secured according to accepted methods of raising food or methods of barter. Food-getting is immoral when the food is secured by stealing or in some other way in which a wrong has been done to society.

Likewise the sex instinct is susceptible of normal expression in such a way as to form the basis for procreating—a perfectly normal and moral act. Or it may form the basis of the highest religious sentiments embodying the idea of God. On the other hand, sex is directly or indirectly responsible for some if not most of the grossest crimes against society.

The older doctrine of infant depravity and the carnal character of human impulses has happily all but passed away. The more modern doctrine that we actually inherit our character deserves a similar fate. The most that we may inherit is a basic constitution which makes the learning of right conduct easy or difficult.

How Character is Developed.—Contrary to the opinion of many, it is the present writer's contention that so far as possible right conduct should be a matter of habit. So long as the child or the adult does the right thing without even consulting other possibilities, the better. By some, such conduct is called unmoral to distinguish it from deliberate choice of the right, which is called moral. From a psychological point of view choice is a decision between two or more possible modes of action. Instead of being given credit for higher conduct by making it a matter of choice, it is better so far as possible to have right conduct done as a matter of habit.

How, then, may right conduct become habituated? In primitive societies the method was somewhat different from our own. In primitive societies conduct was governed by very rigid rules, customs, and taboos. Religion was a large factor in these practices. Many social activities such as marriage, eating, worship, and even fighting and hunting were governed by ceremonies.

"Thou shalt" and "thou shalt not" were written large in the life of primitive man.

The origin of the taboos and ceremonials presents an interesting problem. Certainly no common source would explain all of them. They were, however, evolved to govern conduct. Death, pestilence, and danger together with escape from such calamities led primitive man to draw many false as well as many sane conclusions. When such conclusions were drawn in the councils, taboos were solemnly set up to prevent a recurrence of these things to himself or others. Such taboos were handed down from generation to generation. They inflexibly governed man's social conduct.

As society advanced, many of the taboos were called into question. As soon as questions were raised the taboos began to lose their power. A period of conflict ensued after such questions were raised and in time the taboo was discarded. As primitive taboos were broken down, custom and habits began to take their place. With the change in control the method of "thou shalt" and "thou shalt not" ceased to be effective. The problem then became one of habit formation. How, then, are habits formed?

Habits and Character.—In his famous four laws of habit formation, William James[1] has given us the answer to this question. These laws are: (1) launch yourself with as strong and decided an initiative as possible; (2) never suffer an exception to occur; (3) seize the very first possible opportunity to act on every resolution you make; (4) keep the faculty of effort alive in you by a little gratuitous exercise every day.

While these maxims were written for adults and persons old enough to govern their own conduct, they apply equally well to habit formation in children, except that some of the work is left to the parent. For example, the child cannot be expected to launch himself with a strong initiative; but it is the parent's duty by rewards and praise to favor right responses and by pain and blame to punish wrong responses. Likewise, in the other parts of the program the parent aids the child. It is not to be understood that, as a result of the parent's aid, the child will fail to develop principles by which he can pass upon new situations and decide for himself what his conduct will be. It does mean, however, that in routine situations of life right responses will become habitual.

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[1] William James, *Psychology* (Briefer Course), Henry Holt & Co., 1890, Ch. X.

Just how far habits may be generalized is a disputed point. Some have claimed that habits are always specific. If so, a habit pattern would function only when a situation identical with the one in which the pattern first functioned appeared, and the response would be identical also. Practical observation shows that the two situations do not have to be identical but only similar for the habit to function. If a child has formed the habit of not taking a piece of candy belonging to his brother, he will not take another kind of candy or apples which belong to his brother. Probably he will refrain also from taking things which belong to other members of the family. This is what is meant by a generalized habit. Common observation shows that such habits are formed. This is the task of the parent. When the child has learned to distinguish his own rights from those of others and how to share fairly things held in common, much of his moral training has been accomplished.

The method is simple in principle. It can be accounted for by the laws of learning, the laws of use, disuse, and effect. Right conduct becomes habitual through practice. Practice of one type of action rather than another, other things being equal, comes through the satisfaction secured through practice. Other practices are dropped because they produce annoyance.

Some Causes of a Bad Character.—How, then, do some children learn to steal, to lie, or to swear? If the child sees some object which he wants, the tendency is to secure the object without regard to ownership. If the object belongs to another, he must find that it does not pay to take it without permission. But suppose the child appropriates the object and is not apprehended. He secures pleasure from what society has decided is an immoral act. Of course, he cannot steal indiscriminately, but he will learn when and how to steal. He steals because he gets a reward from the stealing. Normally the child learns not to steal because he is taught that certain things do not belong to him and these he must leave alone. If he tries to take such objects, pain is the result. By such methods the average child comes to have a high regard for the property rights of others. If he has been successful in stealing upon certain occasions, then corrective training is necessary.

The corrective measures for such practices are not easy to discover or to apply. In general, correction can be accomplished by setting up a situation or situations where the child loses rather than gains from stealing. The writer knows of a boy who stole and was treated in the following fashion to break him of the habit. It was arranged so that whenever the boy took anything not only was it taken from him but his books and playthings were taken from him when he was not looking. Soon the boy complained to the teacher that his things were being stolen. This furnished an excellent opportunity for a lesson on property rights. The boy saw the *implications* and did not steal thereafter. Not always is the lesson so easy. The important thing is that wrong conduct brings pain and not pleasure.

Lying is not essentially different from stealing. The small child does not make better distinctions between statements of what might have happened and what did happen than he does between what belongs exclusively to him and what belongs to others. If the child is confronted with a problem of answering a question, he may not clearly distinguish the correct answer from the wrong answer. Often the emotional state of the questioner suggests the immediately safer answer to make. If this is the wrong answer, but the child escapes punishment by it, he is being taught to be a liar.

As he grows older the child may be strengthened in this tendency by examples from his parents and playmates. How common it is for mother or father to tell at least "white" lies in the presence of children. Other children tell lies. How easy, therefore, it is for the child to get examples of and training in lying! Here again, corrective measures are not easily secured. The principle involved in correction is a reward for truth-telling and pain or annoyance for lying.

In the case of swearing the situation is a little different. There is usually no direct reward for swearing. The child learns to swear by hearing other people swear. This may be at home, on the playground, or on the street. The first attempts at swearing are likely to be looked upon as "cute" or "smart" and thus a certain social approbation is given. This situation is more common among associates. Such expressions are lauded. The child who swears is often the hero. False notions of values are established and thus the child forms the habit of swearing.[2]

How to Improve a Bad Character.—The answer to the question of how to prevent the formation of such habits, as has already been indicated, is only a matter of correct emotional attitudes toward the right response. If a clear, steadfast, consistent attitude toward stealing, lying, swearing, bullying, teasing, fighting, temper tantrums, cleanliness, work, and play is maintained, the child will develop into a normal individual. If the opposite tendencies are present or if an inconsistent attitude is held toward wrong responses, the opposite practices may develop. It is probably unnecessary to state that while the principles involved are simple, the practical working out of the principles is quite another thing.

Ideals.—The methods already described may be satisfactory for meeting the usual problems of everyday life. They are not sufficient for meeting new situations in life. Just as motor habits are sufficient for meeting the usual problems but not the new problems, so likewise when new ethical problems arise we must have a way of solving them. Charters[3] has analyzed the steps in this process. He lists five: (1) creating a desire, (2) diagnosing the situation, (3) developing a plan of action, (4) requiring practice, and (5) generalizing ideals.

No real progress in learning of any kind will occur without a desire. There are various ways of developing the desire. Charters illustrates this principle from the life of James Blaine.

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[2] It may be argued by readers that there is nothing wrong with swearing. The answer may be given that swearing at best is an ineffectual form of verbal emotional response. It is often a substitute for more effective expression of ideas or expressing the same idea in another form. It is an indication of a limited vocabulary rather than an exact one.

[3] W. W. Charters, *The Teaching of Ideals,* Edwards Brothers, 1925, and The Macmillan Co., 1927.

Blaine gives credit to his mother who, when he was tempted, had a way of saying to her son, "I am so glad I can depend upon you." Blaine's love for his mother was sufficient to carry him over the crises and create in him a desire to do the right thing.

Dewey[4] and others have pointed out that intelligence is necessary for the highest moral conduct. In order to diagnose a situation it is necessary to see it in its relations. A man with moderate ability may habitually do the right thing, but he can never lead in the establishment of new ethical principles. He may not be able to make intelligent choices in politics and in business.

It is not always the most intelligent person who is the most moral, but it is he who has the capacity to make such decisions. This applies to individual problems and it applies in large economic enterprises and in international relations. A mere desire to do right is not sufficient; a knowledge of what is right is also necessary.

This same need for intelligence holds for the third step—developing a plan of action. In personal matters developing a plan of action is not so difficult, once the problem is clearly formulated. When others are concerned, as in the case of an executive or a political leader, it is necessary to convince the others of the plan of action. Woodrow Wilson planned a League of Nations but he was unable to secure the approval of Congress for his scheme for settling international disputes.

The fourth step—requiring practice—has already been discussed. However, in the type of problems we are now discussing, practice is not very possible. In a new situation, it is difficult or impossible to bring to bear previous practice. Yet, in another sense that is really what we do in solving a new problem. We classify it under some previous experience and solve it on that basis. We decide that we should vote for Mr. Jones. Although personally he is no better than Mr. Smith, Jones stands for a reform tax measure which we think would be a great advantage to the state.

Whenever a decision on an ethical question has been reached, the solution will be valuable for that one case alone unless the ideal can be generalized. Habits, we pointed out, were generalized, and so must ideals be generalized to be of greatest worth. It is by this method that great moral principles are evolved. Lincoln is said to have arrived at his conviction on the slavery question when he saw slaves being sold in the open market. The Protestant reformation came as a result of Luther's belief in the evil practices in the church of his day. He generalized his principles and became the founder of a new faith.

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[4] John Dewey, *Moral Principles in Education,* Houghton Mifflin Co., 1909.

It is through the development of ideals that progress in morals is possible. On the basis of taboos and habit alone progress is impossible. Standards can be raised only by evolving new principles of action.

Leadership and Ideals.—Such principles come about in different ways, but most commonly through the leadership of some reformer. The question is not answered, however, until it is possible to explain how the reformer conceived the idea. This, of course, has been done in a way already. Often it comes as a result of a keen analysis of some situation. Ethical problems may be attacked on the basis of logic. Is child labor right? Is war wrong? Such questions may be resolved into problems of their effect upon society. Leaders may decide that modern practice is wrong and that moral reform is necessary. A period of education of the public is necessary. This may consist in revolution either military or civil or in more gradual processes. When adopted, the practice of the reform becomes a habit or custom. The creators of new ideas are not the moralists alone. The artists, in painting, sculpture, and music, create new ideals. Literature is filled with the story of moral progress. This applies not only to the passing age of romanticism but even in the more modern age of realism in literature.

It is these élite of society who make progress possible. Sometimes their ideas are adopted at once, more often the acceptance is delayed. The overthrow of absolute despotism and the establishment of democracy did not come in a day or even in a century. In fact, it has not fully arrived. The history of the abolition of slavery in America is only a part of a larger movement. John Adams might have been the first to say "taxation without representation is tyranny." He was not the first to think of the idea. Neither was the American Revolution the first attempt to establish the fact.

Religion as a Moral Influence.—In closing the discussion of morals or character, which is morals applied to the individual, we should not fail to mention the largest single effort with character formation as its major aim. It makes no difference of what modern religion we are now speaking. They are all moral religions. Yet there is no question that some religions have a higher moral code, or to say it another way, have moved farther in social progress than others. This is true of organized religion as expressed in the church, or religion in its broader sense. We are ready to admit that religious leaders oftentimes have been conservative and not constructive in their functions. The church has often emphasized ritual and form rather than character building. Its methods have often been inefficient. Its leaders have sometimes been mediocre men and yet the church has been the one outstanding influence for the highest values in life. Despite its many deviations its path has ever been forward. The conflicts between sects and denominations have often clouded the main issues, yet these issues have remained the principal issues in life. Plenty of religion is found outside the church, probably more today than in any period since the dark ages, but the great religious teaching continues to be given either in the church or under the general guidance of the church in the home.

Whatever the method of training we must not neglect religion. It represents the main interests in life. We must discern life's values and make a practice of them a habit. Religion is also the source, preserver, and promoter of man's highest ideals. Whenever religion is constructive it deserves support. Whenever it is not, let us lend our influence to make it such. Anything less will be like the folly of a nation trying to establish a monetary system without a substantial gold reserve.

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CHAPTER 20

DISEASE AND HEALTH

Health.—The normal condition of any individual is health. There are, however, many kinds of disease which reduce man's efficiency. Health may be classified as physical, mental, or emotional, and the diseases which attack man may be thus classified also. Such a classification is made arbitrarily for clearness, and the various kinds of disease and health are probably too closely related to be sharply divided in this manner.

Physical Health and Disease.—The normal span of life in this country is now approximately sixty years. Some idea of the improvement made in this respect can be gained from the fact that the death rate per 1,000 of population decreased from 14.8 in 1908 to 12.0 in 1928.[1] This reduction in death rate is primarily due to better conditions of sanitation, to medical and surgical care, and to education concerning health. While there has been an improvement in all ages of life, the most marked improvements are in the early years. The mortality rate per 1,000 for the first year of life has decreased from 19.7 in 1908 to 11.3 in 1928. Mortality statistics for the first five years of life show a decrease from 27.5 in 1908 to 15.7 in 1928. The ten most common causes of death for all ages are as follows:

TABLE 14

Diseases of the heart	18.1%
Cancer and tumors	8.3
Influenza	8.3
Nephritis	8.0
Diseases of the brain	7.8
Accidents	6.6
Tuberculosis	5.8
Malformations and diseases of infancy	5.4
Bronchitis and pneumonia	3.8
Diabetes	1.7

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[1] Latest statistics available from U. S. Department of Commerce.

Mortality is slightly higher for men than for women and higher for the foreign born than for the native born. The rate for negroes is about 10 more per 1,000 or nearly double that for whites.

Most diseases may attack a person of almost any age, but certain diseases are common to childhood and seldom attack adults. Mumps, measles, scarlet fever, diphtheria, and whooping cough take their toll in sickness, injurious effects, and death, chiefly among children but occasionally among adults. Before 3 years of age whooping cough takes the largest toll. Measles and mumps are more common but not so fatal as diphtheria and scarlet fever. Colds, influenza, and other diseases common to adults also attack children and affect them very severely.

Sickness.—The toll of disease is not only in lives taken but in loss of efficiency and loss of working time. On the average men lose seven or eight days of work each year from illness severe enough to keep them from working. Women lose from eight to twelve days per year. Children lose six or seven school days out of 180 days, or at the rate of twelve to fourteen days per year. The most common causes of loss of working time for both children and adults are colds, grippe, and influenza. Among children, the common children's diseases are next most common in causing loss of working time; among adults digestive and nervous diseases are the next most important factor. To all of these figures must be added an undetermined loss due to ailments which are not severe enough to keep the individual from going to work or school, but which certainly exert a decided influence upon the amount and quality of work which he is able to do.

In addition to the diseases which cause illness and death, there are many defects which reduce efficiency more or less permanently. Some of the most reliable information indicates that as many as 45% of the population have diseased tonsils, 39% have serious dental defects, 27% have defective vision, and 12% have defective hearing. Of course, some individuals suffer from several different defects; therefore, these figures give no indication of the number of persons without any of these defects.[2]

Figures given by the Life Extension Institute.

Despite all defects and diseases, the span of life is increasing, and man is now healthier while he lives than in any period known in history. However, there is much room for further improvement. While prevention of disease is being stressed by doctors and surgeons, many still wait until they are severely ill before seeking treatment. Sanitation and hygiene have made great strides, but there is much yet to be done in these fields. Much may yet be learned about both preventive and curative medicine.

One serious problem which prevents more rapid improvement in conditions of individual health is the high cost of medical attention. Medical, dental, surgical, and hospital bills are a large item in the budget of many people. The well-to-do are able to meet these expenses, and in large cities free clinics have been established for the care of the poor. The real problem is for the large middle class of people, who cannot afford to pay the fees for regular service, and who cannot get the free service even if they are willing so to humiliate themselves. Whether Rosenwald's plan of reasonably priced clinics will solve the problem remains to be tested. Certain cities are experimenting with community health clinics. If all such plans fail, the much discussed public control of medical service may become necessary.

Mental Health and Disease.—Whether mental health or disease is primarily a matter of inheritance or a matter of training is a subject of much debate. Terman and Spearman, while not agreeing on the nature of intelligence, both emphasize the innate character of intelligence. Watson, on the other hand, recently made the rather startling statement that, given a *healthy* baby at birth, he would make of it practically anything desired. It should be noted that Watson made the condition that it be a healthy baby. Even so, his offer seems rather extravagant.

Whatever the causes, we know something of the distribution of intelligence in the general population. If, as is usual, anything below 70 is considered as feeblemindedness, there are between one and a half and two million feebleminded persons in the United States. In fact, the number is probably considerably larger than this when the foreign-born and colored population are included. Some idea of the seriousness of the defects of these persons becomes apparent when it is remembered that as adults these people will range in ability from complete idiocy to that of an average child of about 11 years.[3]

There is another group of six million or more who will never reach a higher level of intelligence than that of a child of 13 years. While such people can get along fairly well in normal situations, they are not able to make difficult judgments or to adapt to new and complicated life problems.

What can be done about this situation? In many cases nothing needs to be done about it. Millions of these people adjust to life without serious difficulties. They are the hewers of wood and the drawers of water. The modern organization of business and industry provides plenty of places for men and women of mediocre ability.

Yet, if the status of intelligence of these people can be improved, as Freeman has shown can be done (see Chapter 12), by training, then it behooves society to provide the best possible training for them. For the higher grades of these people, this means much the same kind of training as normal children receive in the grades and possibly in some cases in the junior high school, but at a slower rate. For the middle group, it means training in special classes. In such classes the regular training is given so far as practicable, and training in the handicrafts is added.[4] In other words, the child is taught the practical arts of living. With the lowest grades little can be done. Many must be cared for in institutions. Others will be assigned the simple menial tasks of life. If sufficiently sheltered, they may live simple, useful, happy lives.

The opposite of this picture is the corresponding millions of superior children, as many and as superior as those just discussed are inferior. They will be the leaders of the next generation. Correspondingly much more has been done for the lower mental grades of society than for the upper levels. When society comes to realize fully the responsibility and opportunities for the education of this superior group, democracy will have made great strides in vindicating itself.

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[3] This statement is based upon Terman's adult average age of 16. If this is too high, as Brigham and others believe, the ages should be scaled down accordingly.

[4] An excellent study of the problem and treatment of subnormal children is presented in an article by P. A. Witty and Florence Beaman, "Practices in Special Classes," *Educational Trends,* (January, 1932) Vol. 1, No. 1, School of Education, Northwestern University.

The topic of mental health might be extended to include habits of work and study. It might also apply to what kinds of work are done as well as to the amount. Such an extension would lead us too far afield from our main problem and will not be included here.

Emotional Health and Disease.—Mental disease may be looked upon as the lack of mentality or intelligence. Emotional disease is not directly comparable to mental disease, in that it does not necessarily depend upon the lack of emotionality. There may be too little, too much, or abnormal emotional growth. Emotional disease is any serious deviation from normal emotional development.

Something of the way the emotional life of the child is built up was described in Chapter 15. When this development is normal, the person is said to have a normal emotional life. If the conditions are of a certain type, the results are satisfactory; if not, the results are unfavorable. In other words, both favorable and unfavorable results are equally due to training. In one case the conditions, rewards, and punishments are of one sort, and in the other case they are of another sort.

Of course, as pointed out in the previous chapter, there may be certain predispositions which favor or tend to defeat such growth. So far as the training is concerned, the results are conditioned by the laws of learning. The predispositions to emotional disorders are of various sorts. There are diseases of the nervous system which predispose the individual to unfavorable emotional development. Encephalitis is one such disease. Brain injuries may be conducive to such conditions. The cerebrum exercises an inhibitory influence of certain kinds. Decerebrated animals exhibit certain characteristics of rage. Brain injury may cause similar results.

Certain other bodily diseases predispose the individual to faulty emotional growth. In fact, any serious disease is likely to hamper emotional health. The child after even a short illness is likely to exhibit a bad disposition for some time. The results here are indirect, but disease sets up the conditions for these dispositions.

As has already been indicated, however, the major emotional disorders are matters of faulty conditioning. Morgan points out how joy and depression may be developed to excess, how anger and fear may be overdeveloped or conditioned by wrong stimuli resulting in irritability, temper tantrums, anxiety, or phobias. Love and hate may be too weak or strong. One may love himself too much or he may love others falsely or in perverted ways. On the other hand, he may hate himself or others without cause. Enough has been said to indicate some of the common perversions in emotionality.

Probably as many people are as seriously affected by emotional disorders as by a lack of intelligence. Probably nearly a million such people are in asylums, sanitaria, and hospitals for the insane in this country. Not all, but a large part, of this group are there because of emotional disorders. Many more millions of people suffer more or less serious emotional disease.

When we learn more about training the emotions and spend more of our time in such training, our emotional lives will improve in something the same way as improvement has come about in bodily health and general education.

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